PB90-178526

# Superfund Record of Decision (EPA Region 6): Homestake Mining Company, Cibola County, New Mexico (First Remedial Action), September 1989

(U.S.) Environmental Protection Agency, Washington, DC

27 Sep 89

U.S. Department of Commerce
National Technical Information Service
NTIS

PB90-178526

United States
Environmental Protection
Agency

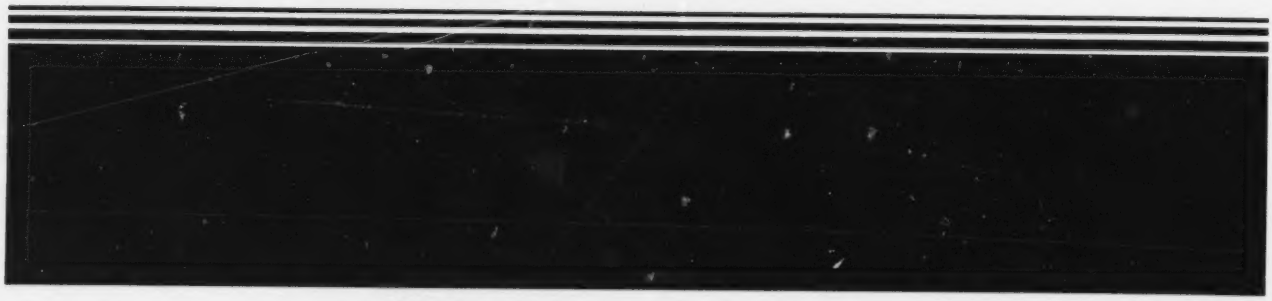
Office of
Emergency and
Remedial Response

EPA/ROD/R06-89/050
September 1989

EPA

# Superfund Record of Decision:

## Homestake Mining, NM



REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

50272-101

| REPORT DOCUMENTATION PAGE | 1. REPORT NO. EPA/ROD/R06-89/050 | 2. | 3. Recipient's Accession No. PB90 178526/AS |
|---|---|---|---|
| 4. Title and Subtitle<br>SUPERFUND RECORD OF DECISION<br>Homestake Mining, NM<br>First Remedial Action - Final | | | 5. Report Date<br>09/27/89<br>6. |
| 7. Author(s) | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address | | | 10. Project/Task/Work Unit No.<br>11. Contract(C) or Grant(G) No.<br>(C)<br>(G) |
| 12. Sponsoring Organization Name and Address<br>U.S. Environmental Protection Agency<br>401 M Street, S.W.<br>Washington, D.C. 20460 | | | 13. Type of Report & Period Covered<br>800/000<br>14. |

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Homestake Mining Company (HMC) site consists of a uranium processing mill and two tailings embankments in Cibola County, New Mexico, about 6 miles north of Milan. The tailings embankments contain a combined total of 22 million tons of tailings material covering 225 acres. Four housing subdivisions are south and southwest of the mill with the nearest residence approximately 0.6 miles from the tailings embankments. In 1983 elevated levels of selenium were found in offsite ground water prompting EPA to require HMC, under a consent agreement, to supply municipal water to residents in the subdivision south of the mill. Furthermore, HMC implemented an aquifer protection and restoration program including ground water injection/collection efforts at the site, which was subsequently formalized, modified and approved pursuant to requirements of the New Mexico Water Quality Control Commission. The restoration program continued to operate and has been largely successful in onsite containment of tailings seepage. This Record of Decision addresses possible radon releases from the uranium mill operations into residential subdivisions. From 1987-1989 HMC, under an Administrative Order on Consent, conducted an investigation as to whether radon associated with the uranium mill tailings operation might be influencing outdoor and indoor radon levels in the subdivisions. Based on the results of HMC's investigation, EPA has determined that the uranium mill and tailings embankments at the site are not contributing significantly to offsite subdivision radon contamination and that it does (Continued on next page)

17. Document Analysis a. Descriptors

Record of Decision - Homestake Mining, NM
First Remedial Action - Final
Contaminated Media: None
Key Contaminants: None

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

| 18. Availability Statement | 19. Security Class (This Report) None | 21. No. of Pages |
|---|---|---|
| | 20. Security Class (This Page) None | 22. Price |

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

EPA/ROD/R06-89/050
Homestake Mining, NM

16. Abstract (Continued)

not have authority under CERCLA to address radon levels due to natural soil concentrations. In June 1986 the Nuclear Regulatory Commission (NRC) resumed jurisdiction over uranium mills in the State of New Mexico and issued HMC a radioactive materials license. NRC intends to close the site pursuant to their regulations and will coordinate their requirements with EPA.

The selected remedial action for this site is no further action for the Radon Operable Unit. However, EPA is recommending radon reduction techniques to residents having elevated indoor radon levels.

# RECORD OF DECISION
# HOMESTAKE MINING COMPANY
# RADON OPERABLE UNIT
# CIBOLA COUNTY, NEW MEXICO
# SEPTEMBER 1989

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 6, DALLAS, TEXAS

DECLARATION
FOR THE
RECORD OF DECISION

## SITE NAME AND LOCATION

Homestake Mining Company
Cibola County, New Mexico
Radon Operable Unit

## STATEMENT OF PURPOSE

This decision document presents the radon decision for the Radon Operable Unit of the Homestake Mining Company (HMC) site selected by the United States Environmental Protection Agency (EPA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

## STATEMENT OF BASIS

The decision is based upon the administrative record for the Homestake Mining Company Superfund Site. The attached index (Appendix C) identifies the items which comprise the administrative record upon which this decision is based.

## DESCRIPTION OF THE SELECTED REMEDY

The EPA has decided that it will take no further action for the Radon Operable Unit as defined by indoor and outdoor radon concentrations in four subdivisions near the HMC site.

This action is part of a comprehensive response action for the HMC site. To date, pursuant to a 1983 Consent Agreement signed by HMC, alternate water has been supplied to residents in subdivisions near the HMC site whose wells were contaminated by tailings seepage. Remedial activities addressing remaining tailings contaminated ground water, source control and onsite surface reclamation have been and will continue to be implemented by HMC under the direction of the U.S. Nuclear Regulatory Commission (NRC), pursuant to the facility's NRC license, and integrated with the New Mexico Environmental Improvement Division's (NMEID) approved aquifer protection and restoration program as authorized by the facility's state-required Ground water Discharge Plan (DP-200). Agency responsibilities for the remedial action at the HMC site will be formally delineated in an agreement to be signed by the EPA and NRC.

## DECLARATION

Based on the results of the remedial investigation, EPA has determined that the uranium mill and tailing embankments at the HMC site, though a potential source of radon near the site, are not contributing significantly to off-site subdivision radon concentrations. EPA has concluded that the principle cause of elevated indoor radon in homes (homes having annual average radon concentrations exceeding 4 pCi/l) is related to local, native soil sources of radon in the subdivisions, and is a function of the type and quality of housing construction. As a result of this finding, EPA has determined that it does not have authority under CERCLA Section 104 to address indoor radon concentrations identified as elevated in the Radon Operable Unit. The no action decision formalized in this ROD, however, does not constitute a finding by EPA that adequate protection has been achieved in the subdivisions. Because 8 out of 66 residences investigated for radon had annual indoor radon concentrations above the 4 pCi/l action level guideline (between 4.1 and 6.7 pCi/l), EPA is recommending radon reduction techniques to residents having elevated indoor radon levels. House-specific radon reduction techniques were identified during the remedial investigation and feasibility study in a manner consistent with EPA's national radon policy.

The Nuclear Regulatory Commission and the State of New Mexico have reviewed the proposed plan, as identified in the remedial investigation/feasibility study (RI/FS), and Proposed Plan Fact Sheet, and support the remedy described in this Record of Decision. (Appendices D,E)

Robert E. Layton Jr.
Robert E. Layton Jr., P.E.
Regional Administrator

Sept. 27, 1989
Date

TABLE OF CONTENTS


PAGE

1. Site Name, Location, and Description ..... 1

2. Site History and Enforcement Activities ..... 1

3. Community Relations History ..... 3

4. Scope of Radon Operable Unit ..... 4

5. Site Characteristics ..... 5

   5.1 Meterology ..... 5
   5.2 Geology and Hydrology ..... 5
   5.3 Radon ..... 6

6. Summary of Site Risks ..... 9

7. Description of Alternatives and Comparative Analysis ..... 9

8. Selected Remedial Approach ..... 10

9. Statutory Authority Findings ..... 11

Figures 1-6 and Tables 1-8

REFERENCES

APPENDICES

A. Evaluation of Applicable or Relevant and Appropriate Requirements

B. Agency for Toxic Substances and Disease Registry (ATSDR)/Center for Disease Control (CDC) Evaluation

C. Administrative Record Index

D. U.S. Nuclear Regulatory Commission Correspondence

E. State of New Mexico Correspondence

F. Responsiveness Summary

## LIST OF FIGURES


1. Site Location Map
2. Local Site Map
3. Regional Map
4. Subdivisions Map of Annual Average Indoor Radon Concentrations
5. Subdivisions Map of Annual Outdoor Radon Concentrations
6. Probability Distribution of Corrected Indoor Radon Concentrations in Subdivisions


## LIST OF TABLES


1. Measured and Corrected Indoor Radon Concentrations
2. Measured and Corrected Outdoor Radon Concentrations
3. Summary of Corrected Indoor Radon Levels by Quarterly Averages and Subdivisions
4. Summary of Corrected Outdoor Radon Levels by Quarterly Averages
5. Indoor Radon Concentrations: Corrected Twelve-month Averages in pCi/l for Frame Houses and Trailers
6. Indoor Corrected Radon Concentrations (Twelve-month Averages) Based on General Construction Type and Quality of Residence
7. Comparison of Indoor and Outdoor Corrected Radon Concentrations
8. Recommendations for Reducing Radon Concentrations in Residences Above 4 pCi/l

## 1. SITE NAME, LOCATION, AND DESCRIPTION

The Homestake Mining Company (HMC) site is located in Section 26, Township 12N, Range 10W of Cibola County, New Mexico, about 5.5 miles north of Milan (figure 1). The site consists of a uranium processing mill and two tailing (byproduct materials generated from milling operations) embankments situated in the San Mateo drainage at an elevation of approximately 6,600 feet (figure 2). One tailings embankment, which is still in use, consists of two cells covering approximately 175 acres, with tailings totaling 21 million tons and measuring 95-100 feet high. This tailing embankment is constructed of coarse tailings material, and is largely covered with water on top. The second tailings embankment has not been in use since 1962, covers approximately 45 acres, measures 25 feet high, and contains 1.225 million tons of tailings. This embankment has greater than 95% of its top covered with at least 6 inches of soil.

Four housing subdivisions are located south and southwest of the mill and associated tailings embankments, and are known as Murray Acres, Broadview Acres, Felice Acres, and Pleasant Valley Estates. The nearest residence is located in Murray Acres and is approximately 0.6 miles from the center of either tailings embankment.

## 2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The HMC mill has been in operation since 1958 and was originally licensed by the Atomic Energy Commission. Milling operations were constructed and originally operated as two distinct partnerships, the Homestake-Sapin Partners with a milling capacity of 1,750 tons per day (tpd) and Homestake-New Mexico Partners with a milling capacity of 750 tpd. In November 1961, the Homestake-New Mexico Partnership dissolved and the property was ultimately acquired by the Homestake-Sapin Partnership. The operating facilities from both operations were combined and expanded to bring the optimal operating capacity of the mill to 3,400 tons per day. In April 1968, the name of the Partnership was changed to United Nuclear-Homestake Partners and in March 1981, Homestake purchased United Nuclear Corporation's interest and the operation became Homestake Mining Company - Grants.

Since the onset of milling operations at the HMC site, an alkaline leach-caustic precipitation process has been employed to extract and concentrate uranium oxide from uranium ores that have historically averaged from 0.05 to 0.30 percent $U_3O_8$. The concentrate is a semi-refined uranium compound known as yellowcake that averages 92 percent $U_3O_8$. Ore processed at the HMC mill has primarily come from 5 underground uranium mines and an Ion Exchange Facility in Ambrosia Lake, New Mexico. These facilities are operated by HMC and are located about 18 miles northwest of Grants, New Mexico in the southeastern part of McKinley County.

Tailings at the site are composed of uranium-depleted fine and coarse sand fractions and slimes. The tailings have been and continue to be deposited above ground on and within the active embankment by means of wet cyclones which separate the material into coarse and fine fractions. The tailing

piles are treated to minimize water and wind erosion. Treatment has included stabilization with solid objects such as erosion control blankets and used tires, by wetting with water, and with chemical agents which form a crust on the surface of the sands.

In 1974, the State of New Mexico signed an agreement with the U.S. Nuclear Regulatory Commission (NRC - formerly the Atomic Energy Commission) authorizing the State to regulate uranium milling activities under the Atomic Energy Act, as amended. After becoming an "Agreement State" in 1974, New Mexico issued HMC a radioactive materials license for their uranium mill.

In that same year, the New Mexico Environmental Improvement Agency (now the New Mexico Environmental Improvement Division, or NMEID) requested EPA to assist in a survey of uranium mining and milling activities in the Grants Mineral Belt to determine the impact of these activities on surface and ground water in the area. The sampling program was undertaken early in 1975, and results indicated that ground water in part of the alluvial aquifer downgradient from the Homestake mill exhibited elevated selenium concentrations. A number of residential wells in two subdivisions south of the HMC site were subsequently found to be contaminated.

The site was placed on the National Priorities List (NPL) of Superfund sites in September 1983, primarily due to ground water contamination. In June of 1983, as a result of the elevated selenium concentrations in off-site locations, HMC signed a consent agreement with EPA to supply municipal water to residents in the subdivisions south of the mill. All water supply hookups were completed during April 1985.

As a result of elevated selenium concentrations detected in the neighboring subdivisions, HMC implemented an aquifer protection and restoration program at the site. This program was subsequently modified and approved pursuant to requirements of the State of New Mexico Water Quality Control Commission under Ground Water Discharge Plan DP-200. DP-200 was initially submitted to the NMEID in November of 1981 and last renewed in July of 1989. DP-200 requires continued operation of ground water injection and collection systems at the site and quarterly and semi-annual monitoring of water-level and water quality conditions with time. Monitoring results to date indicate that injection/collection efforts under DP-200 have been largely successful in flushing previously contaminated zones in the alluvium and underlying Upper Chinle aquifer resulting in onsite containment of tailings seepage.

On June 30, 1987, HMC voluntarily entered into an Administrative Order on Consent (AO) with EPA to conduct a Remedial Investigation (RI) and Feasibility Study (FS) on radon in accordance with CERCLA. Limited data collected by NMEID at that time suggested that radon associated with HMC's uranium mill tailings operations might be significantly influencing indoor and outdoor levels in the neighboring subdivisions. To address this concern, the AO called for the performance of a RI/FS to address the levels and sources of radon that may impact the four subdivisions southwest of the HMC mill and tailings embankments. HMC conducted the RI/FS studies with oversight by

EPA between October 1987 and January 1989, and completed final RI/FS documents in July 1989. The contents of these documents form the basis of this ROD.

In June 1986, at the request of the Governor, the State of New Mexico returned its regulatory responsibility for uranium mills back to NRC. NRC subsequently issued HMC Source Materials License SUA-1471 governing mill operations and tailings disposal activities at the site. Discussions between EPA, NRC, and the NMEID followed in order to determine the most timely and effective way to oversee regulatory requirements at the site. Results of these discussions are to be formalized in an agreement between EPA and NRC governing remedial action at the HMC site. In this regard, NRC will coordinate its ground water requirements pursuant to 10 CFR 40, Appendix A with NMEID, and when mill operations are discontinued will require HMC to implement a final mill site reclamation plan for long-term stabilization and closure (200-1000 years).

Present milling rates continue to be approximately 18,000 to 19,000 tons per month with an operating schedule of seven days per week.

## 3. COMMUNITY RELATIONS HISTORY

There has been some media interest in the HMC Superfund site, most of which occurred during the site's initial NPL listing and in response to EPA's decision to extend the Milan public water supply to subdivision residents. Since installation of alternate water supplies in 1985, interest from individual citizens in subdivisons near the HMC site has been low to moderate.

EPA published and distributed a fact sheet in October 1986 updating interested citizens on the status of the HMC site, and announcing plans for further radon studies in subdivision areas. In August of 1987, in accordance with the June 1987 AO, a letter was sent to all subdivision homeowners inviting them to participate in a 15-month radon study. In order to answer questions related to the proposed study, EPA distributed a second fact sheet in September 1987 and on September 22, 1987, held a public information meeting at the Cibola County Convention Center in Grants, New Mexico.

HMC received acceptance letters along with completed questionaires from 66 of a possible 67 homeowners for preliminary and long-term indoor radon monitoring. Participating residents received results of the first 6 months of monitoring in June 1988, were sent monitoring results for months 7 through 9 in October 1988, and results for months 10 through 15 in September 1989.

Notice of EPA's Proposed Plan was provided to potentially affected persons through newspaper notice on July 19, 1989, and was followed by a direct mailing to individuals and groups on the site mailing list. The mailing consisted of a fact sheet describing the results of the radon investigations and the Proposed Plan for no action. The Administrative Record for the Radon Operable Unit was sent to the New Mexico State University Grants

Library on July 17, 1989. The public comment period on the Proposed Plan was established from July 31, 1989, through August 28, 1989. The fact sheet provided the opportunity for a public meeting on the Proposed Plan, and a request for such a meeting was received on August 17, 1989. The requested public meeting was announced in the local newspaper on August 18 and held in Grants, New Mexico on August 28, 1989. To accommodate the public meeting, the comment period was extended by EPA through September 1, 1989. Comments received are addressed in the Responsiveness Summary (Appendix F).

## 4. SCOPE OF RADON OPERABLE UNIT

Environmental concerns at the HMC site involve potential or actual releases of hazardous substances, pollutants, or contaminants to air, groundwater, and soils. As a result, EPA has grouped environmental concerns at the site into three categories or operable units. These are:

- OU One: Tailings seepage contamination of ground water aquifers.
- OU Two: Long-term tailings stabilization, surface reclamation, and site closure.
- OU Three: Radon concentrations in neighboring subdivisions.

As discussed in Section 2.0 above, specific environmental concerns and problems at the HMC site have been addressed by either EPA, NMEID, or NRC since inclusion on the NPL. To date, OU One has been addressed by both EPA and NMEID. EPA required HMC to provide neighboring subdivisions with alternate water supplies (1983 Consent Agreement with HMC) in response to off-site tailings seepage contamination of domestic wells, while NMEID has required HMC to operate an aquifer protection and restoration program in areas contaminated by tailings seepage pursuant to New Mexico Water Quality Control Commission Regulations (Ground Water Discharge Plan DP-200). Alternate water was extended to the neighboring subdivisions in 1985, usage costs pre-paid by HMC for ten years, and the Water Right transfered to the Village of Milan, New Mexico by quitclaim deed. As discussed earlier, the aquifer protection and restoration program has been effective in reversing natural ground water flow gradients in the San Mateo alluvial and Upper Chinle aquifers and containing tailings seepage contamination on HMC property. On July 27, 1989, this restoration program was renewed for a period of 5 years by NMEID.

OU One is also being addressed by NRC under mill tailings regulations in 10 CFR 40, Appendix A, pursuant to the Atomic Energy Act of 1954, as amended. To date, NRC has implemented a detection monitoring and hazardous constituent data gathering program at the site and has established ground water protection standards and points of compliance for the tailings disposal area. Monitoring data collected under the direction of NRC indicate that ground water protection standards are exceeded at established onsite point of compliance wells, and therefore NRC has requested HMC to submit a corretive action plan for ground water. NRC will, in conjunction with NMEID's requirements, require HMC to implement a corrective action program at the site, with the objective of long-term remediation of tailings contaminated ground water.

OU Two above is being addressed by NRC under mill tailings regulations in 10 CFR 40, Appendix A. In accordance with these regulations, NRC will require HMC to submit a final reclamation plan for NRC approval, and upon

HMC's decision to terminate its operations, to implement the plan for the tailings disposal area which meets the technical requirements of 10 CFR 40, Appendix A, as amended, which conform with EPA standards in 40 CFR 192. These activities will address long-term stabilization and closure of the tailings disposal area. To date, HMC has implemented a land clean-up program for windblown tailings as required by 10 CFR 40, Appendix A and NRC licensing requirements, and will continue this program pursuant to NRC requirements until the site is closed. HMC has also submitted a reclamation plan to NRC as required by Source Material License SUA-1471. NRC is currently reviewing this plan.

The third OU is authorized by this ROD and addresses radon concentrations in neighboring subdivisions. The subdivisions themselves are located south and southwest of the HMC site. Limited data collected by NMEID prior to conduct of the radon RI suggested that the HMC mill and tailings embankments might significantly influence radon concentrations in the subdivisions and thus pose a threat to human health and the environment. As a result, EPA required an investigation addressing the concentrations and possible sources of radon in the subdivisions. The purpose of this ROD is to discuss the results of the radon investigation and formalize EPA's decision that no additional action for off-site radon is necessary.

## 5. SITE CHARACTERISTICS

### 5.1 Meterology

The HMC site area has an arid to semi-arid continental climate which receives more than 60 percent sunshine each day, on average, throughout the year. On an annual basis, winds are moderate and are primarily from the southwest. Average yearly precipitation is about 10 inches, most of which occurs in the summer with generally dry conditions persisting year-round.

### 5.2 Geology and Hydrology

The HMC site and subdivisions are located on the northeast flank of the Zuni Uplift, a tectonic feature which is characterized by a core of Precambrian crystalline basement rocks partially mantled by Permian and Triassic sedimentary rocks. The Zuni Uplift is surrounded by several tectonic depressions, including the Gallup Sag to the west-southwest and Acoma Sag to the southeast. Major faults occur along the southwest flank of the Zuni Uplift and a number of minor faults are mapped in the remainder of the region. No active major or minor faults are known to be in the vicinity of the site. Figure 3 summarizes the region's geography.

The site is underlain by the San Mateo alluvium to depths of over 120 feet. The alluvium is generally sandy silt; however, two distinct sand and gravel horizons occur at the top and bottom of the unit. The lower sand and gravel horizon is relatively continuous throughout the area and is a source of water in the region. Ground water in the San Mateo alluvium flows southwest north of the HMC site. Directly underlying the alluvium is the Chinle Formation (with Upper and Lower members) which is in turn underlain by the San Andres Limestone. As discussed earlier, the San Mateo alluvium and Upper Chinle formations are aquifers, have been locally affected by seepage

from the tailings facility, and have been addressed by NMEID's Ground Water Discharge Plan.

The HMC mill and subdivisions are located in the Arroyo del Puerto Valley which is encircled by a number of mineral deposits. To the west-northwest is Haystack Mesa where uranium was first discovered in the Grants Mineral Belt. To the north is Ambrosia Lake, the densest uranium mining and mine ventilation location in the United States. There are also open pit uranium mines, and therefore, outcropping mineralizations at the surface located in the various mesas between Ambrosia Lake and the Arroyo del Puerto Valley. A number of surface excavations are also found in and around the mesas to the east and northeast. To the northeast is the San Mateo Valley which drains air flow from the north side of Mount Taylor where the largest and deepest uranium mine is located. To the east is the Lobo Canyon drainage which also exhibits the residues of several past mining ventures.

The surface water regime of the Mill Site is influenced by the arid to semi-arid climate of the region, the relatively medium to high permeability of the soils and the exposed bedrock in the watersheds. The San Mateo drainage basin which includes the mill site has a drainage area of approximately 291 square miles. The only surface water bodies are several stock ponds, some small ephemeral ponds, and an undetermined number of springs on the flanks on Mount Taylor. None of these water bodies are affected by the Mill operations, because they are geographically remote and not hydrologically connected with the site.

5.3 Off-site Radon

The specific element of concern addressed for this Operable Unit is radon-222, which is the first decay product of radium-226. Radon is an inert gas that decays with a half-life of 3.8 days into short-lived, primarily alpha-emitting radon progeny. Radon levels were monitored in the following subdivisions south and southwest of the HMC site during the RI: Murray Acres, Broadview Acres, Felice Acres, and Pleasant Valley Estates. The primary objectives of the radon RI were:

- to accurately measure the annual average indoor radon concentrations in dwellings located near the mill;

- to accurately measure the annual average outdoor radon concentrations in air in the vicinity of the residences located in the subdivisions; and

- to access the significance of the potential influence of the mill and tailings embankments on radon levels in the subdivisions.

A preliminary radon screening program was initiated in October of 1987, after 66 of a possible 67 homeowners indicated their willingness to participate in the study. Results of the preliminary three-day screening indicated a range of indoor radon concentrations from 1.6 to 12.1 pCi/l. In the absence of finding any acute concentrations (exceeding 20 pCi/l), the radon RI focused on long-term radon evaluations. Integrated radon concentrations were measured during a fifteen-month period in three-month intervals. Concurrently, similar integrated radon measurements were made at 28 outdoor locations within the four subdivisions.

A fifteenth-month period (five quarters: October - December 1987, January - March 1988, April - June 1988, July - September 1988, and October - December 1988) was selected to cover the four seasons of the year and to provide measurement for two winter month periods when radon concentrations are usually the highest inside houses due to the homeowner attempts to keep homes tightly sealed against the weather.

Indoor radon data are presented in Table 1 for each residence studied, by lot and block number within each housing subdivision and for each of the five quarters. Both measured and corrected values are presented in this Table. Measured concentrations were corrected by determining the response of a detector to known radon concentrations.

Measured values were calibrated by the following factors for each successive quarter: 1.21, 1.22, 1.18, 1.15, and 1.14. The annual average columns in Table 1 reflect the average for the first four quarters; the second four quarters; and the annual average obtained by combining and averaging the first and fifth quarters (both winter quarters - October through December) with the middle three quarters, respectively. This third calculation gives equal quarterly weight to the first and fifth quarters of the radon survey period. Averages were not calculated for residences where some portion of the data was missing. Collectively, data is missing for one or more quarters for seven residences. In four cases only one quarter's data is missing, in two cases two quarter's data are missing, and in the third case, data are not available for three of the five quarters studied. As Table 1 indicates, the highest measured quarterly radon concentration in homes with incomplete data is 2.9 pCi/l, which is equivalent to a corrected radon concentration of 3.5 pCi/l. Primary reasons for loss of data were monitors which were not collected due to inability to contact the residents. As a result, complete data are available for 59 living units. Footnotes to Table 1 describe the specific reasons for incomplete data. Figure 4 shows the corrected annual average radon concentrations for each of the 59 residences. These averages were obtained by combining and averaging both winter quarters with the middle three quarters.

Measured and corrected outdoor radon data for twenty-eight locations are presented in Table 2. Detector locations are identified in terms of the nearest residence and cover the same period of five quarters covered by the indoor radon study. The calibration factors determined for each quarter for the first through the fifth quarters were 0.75, 0.47, 0.53, 0.79 and 0.95. The last 3 columns of Table 2 contain the corrected annual average radon concentration for the first 4 quarters; the second 4 quarters; and the annual average obtained by combining and averaging the first and fifth quarters results (both winter quarters - October through December) with the middle three quarters, respectively. Figure 5 shows the 28 outdoor monitor locations and corresponding corrected outdoor annual average radon concentrations. These averages were obtained by combining and averaging both winter quarters with the middle three quarters.

Table 3 presents a summary of corrected indoor radon concentrations by quarter and subdivision, and Table 4 a similar summary for corrected outdoor concentrations. The overall annual average indoor radon concentration in the 59 houses is 2.7 pCi/l. The annual average outdoor radon concentration for the 28 monitoring stations is 1.9 pCi/l. Seasonal variation occurred

in the indoor radon concentrations evidenced by higher levels in the quarters having the coldest weather. Only eight residences have annual average radon concentrations greater than 4 pCi/l (12% of the total houses in the subdivision). These eight values are 6.7, 6.2, 5.1, 4.6, 4.5, 4.2, 4.2, and 4.1 pCi/l. There are seventeen residents residing in these eight residences.

Tables 5 and 7 present and compare indoor and outdoor radon concentrations by subdivision and by the quality and type of home construction. Table 6, together with Figure 6, present indoor radon data in three concentration groupings as a function of the quality and type of home construction.

Analysis of the radon data collected during the RI, and summarized in Tables 1-7 and Figures 4-6, allow the following observations to be made:

- Average radon concentrations for trailers are consistently lower than the average concentrations for houses;

- Dwellings with the highest radon concentrations (4.7-6.7 pCi/l) consists of frame houses, two with crawl spaces, one with a slab, and no trailers;

- In most cases, trailers have indoor concentrations which are comparable with outdoor radon concentrations indicating significant indoor/outdoor air exchanges;

- No definitive correlation is apparent between the distance of individual homes from the HMC mill and tailings embankments and annual average indoor radon concentrations;

- No definitive correlation is apparent between the distance of outdoor radon monitors from the HMC mill and tailings embankments and annual average outdoor radon concentrations (correlation coefficients for regression analyses of data for different wind rose sectors varied between 0.07 and 0.56, with a combined four sector coefficient of 0.05).

These observations indicate that:

1) outdoor radon concentrations do not exhibit the degree of variability with distance from the mill and tailings embankments which would suggest atmospheric dispersion of radon from these is significantly elevating the average radon concentration in the subdivisions;

2) indoor radon concentrations are influenced primarily by structural characteristics of individual homes which allow indoor radon concentrations to be dominated by build-up from local sources of radon in the subdivisions.

Potential local radon sources evaluated were building materials used in house construction and soils under or adjacent to the homes with the most elevated radon concentration. Gamma radiation levels inside and exterior of homes with elevated radon did not identify radioactive sources in home building materials. Uranium and radium levels in surface soils collected beneath or adjacent to homes with elevated indoor radon concentrations were

indicative of background levels and provided no evidence that tailings were significant in the soil in the vicinity of these residences. In view of these findings, it is concluded that the primary source of indoor radon in homes in the subdivisions is local soil which emits radon gas. Primary radon entry routes are through cracks and other openings in dwelling floors, with higher indoor levels in frames houses with a crawl space or slab.

## 6.0 SUMMARY OF SITE RISKS

An Endangerment Assessment of the risks to radon exposure was performed for the seventeen individuals residing in the eight houses having annual average radon levels of > 4 pCi/l.

Four conservative models which are in current use for setting regulatory standards were used to provide upper-bound risk estimates for radon concentrations measured in the eight houses. The first three are based on relative risk and are the Time Since Exposure and Internal Analysis models used in the Biological Effects of Ionizing Radiation IV Report (BEIR IV) and the model employed in Report 50 of the International Commission on Radiological Protection (ICRP 50). A fourth model, used in a National Council on Radiation Protection and Measurements 78 Report (NCRP 1984), is based on absolute risk and is used for comparison. The Relative Risk models assume that the risks of exposure from radiation is proportional, or relative to the normally occurring, or background, risk of lung cancer. The Absolute Risk models assume that the risk of radiation exposure adds to the underlying background risk of contracting lung cancer. Lifetables used are from BEIR IV and are corrected for United State background exposure to average indoor and outdoor radon concentrations based on average values from the 1988 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). This UNSCEAR Report was also used to obtain conservative occupancy factors of 80% indoor and 20% outdoor for residents and average radon daughter equilibrium factors of 0.4 and 0.8 for indoor and outdoor radon concentrations, respectively. These latter factors are then used to convert the various radon concentrations into exposures as expressed by working level months per year (WLM/y).

Lung cancer lifetime risks per year for the seventeen residents of the eight houses having more than 4 pCi/l average annual indoor radon concentrations are given in Table 8. The data range from $3.1 \times 10^{-5}$ to $5.9 \times 10^{-4}$ and center around 1 in 10,000 per year of residency for all houses exceeding 4.0 pCi/l and for all age groups. These risks from radon exposure are slightly above EPA's threshold level for remedial action, and therefore EPA is recommending that radon reduction measures be employed by these eight homeowners.

## 7. DESCRIPTION OF ALTERNATIVES AND COMPARATIVE ANALYSIS

Based upon the results of the RI, EPA has determined that the uranium mill and tailings embankments, though potential sources of radon in the area, are not contributing significantly to subdivision radon levels. Therefore, alternatives addressing radon emanations from the mill and tailing embankments were not developed, evaluated or compared. No action for off-site radon was the only remedial alternative examined in relation to the site itself. However, since 8 residences in the subdivisions had annual average indoor radon concentrations above EPA's radon guideline of 4 pCi/l, house by house evaluations were conducted during the RI in order to identify construction features causing indoor radon buildup.

House by house evaluations also permitted the selection of appropriate radon reduction methods for each of the residences with radon levels above 4 Ci/l. These house-specific radon reduction methods were summarized in the July 1989 FS, as recommendations to homeowners (these recommendations will be sent directly to the individual homeowners as well). In accordance with EPA's Citizen's Guide to Radon, radon reduction efforts are recommended within 2 to 3 years of indoor measurements if annual radon levels are between 4 and 20 pCi/l.

## 8. SELECTED REMEDIAL APPROACH

Based on:

A. Long-term outdoor radon monitoring which does not indicate a definitive relationship between concentration and proximity to the HMC mill and tailings embankments;

B. Long-term indoor radon monitoring which indicates that the primary cause of elevated radon concentrations is related to local soil sources and construction features of homes which allow radon build up; and

C. The fact that tailings materials were not identified during sampling in crawl spaces of, or adjacent to residences with elevated radon;

EPA has determined that it does not have the authority under CERCLA Section 104 to address radon concentrations identified in the subdivisions and therefore has selected no further action for the Radon Operable Unit.

Although results of the RI indicate that the mill and tailings embankments are not significant in causing elevated indoor radon in the subdivisions, eight homes marginally exceed EPA's radon actions level guideline. As a result, house by house evaluations were conducted during the RI to identify construction features responsible for radon build up. As detailed in the FS report, house by house evaluations permitted the selection of radon reduction methods for each home (see figure 8). These radon reduction recommendations will be made available to individual homeowners.

While EPA believes that continued subdivisions monitoring is unwarrented at this time, EPA recognizes the need to monitor outdoor radon and windblown particulate levels south of the disposal area to assure that conditions in the subdivisions do not significantly change prior to final site closure. In this regard, EPA will continue to review outdoor radon monitoring and particulates data collected at the facility boundary pursuant to NRC-license requirements. Should an increasing trend in either radon or particulates levels be noted, EPA and NRC will require monitoring or corrective action in the subdivisions, whichever is appropriate.

## 9. STATUTORY AUTHORITY FINDINGS

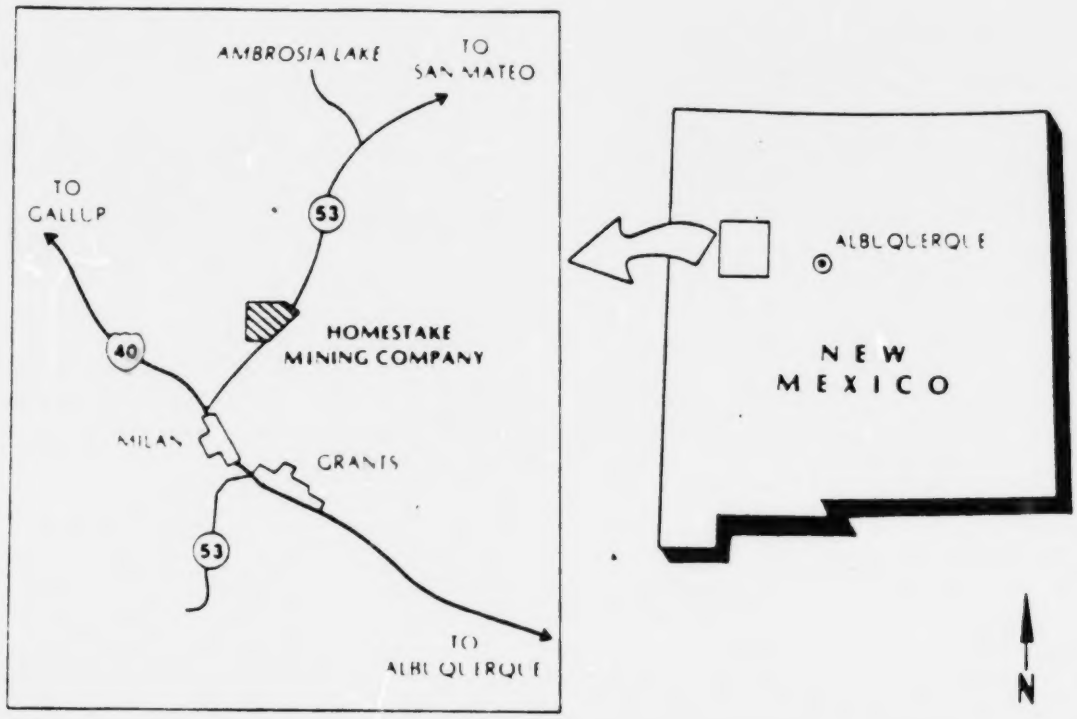
Based on the results of the remedial investigation, EPA has determined that the uranium mill and tailing embankments at the HMC site, though potential sources of radon near the site, are not contributing significantly to off-site subdivisions radon concentrations. EPA has concluded that the principle cause of elevated indoor radon concentrations is related to local soil sources of radon in the subdivisions, and is a function of the type and quality of housing construction. As a result of this finding, EPA has determined that it does not have authority under CERCLA Section 104 to address indoor radon concentrations identified as elevated in the Radon Operable Unit. The no action decision formalized in this ROD, however, does not constitute a finding by EPA that adequate protection has been achieved in the subdivisions. Because 8 out of the 66 residences investigated for radon had annual indoor radon concentrations above the 4 pCi/l action level guideline (between 4.1 and 6.7 pCi/l), EPA is recommending radon reduction techniques to residents having elevated indoor radon levels. House-specific radon reduction techniques were identified during the the RI and FS in a manner consistent with EPA's national radon policy.

FIGURES 1-6

AND

TABLES 1-8

FIGURE 1




**HOMESTAKE MINING COMPANY**
**SITE LOCATION**

# HMC MILL AND SUBDIVISIONS LOCATIONS

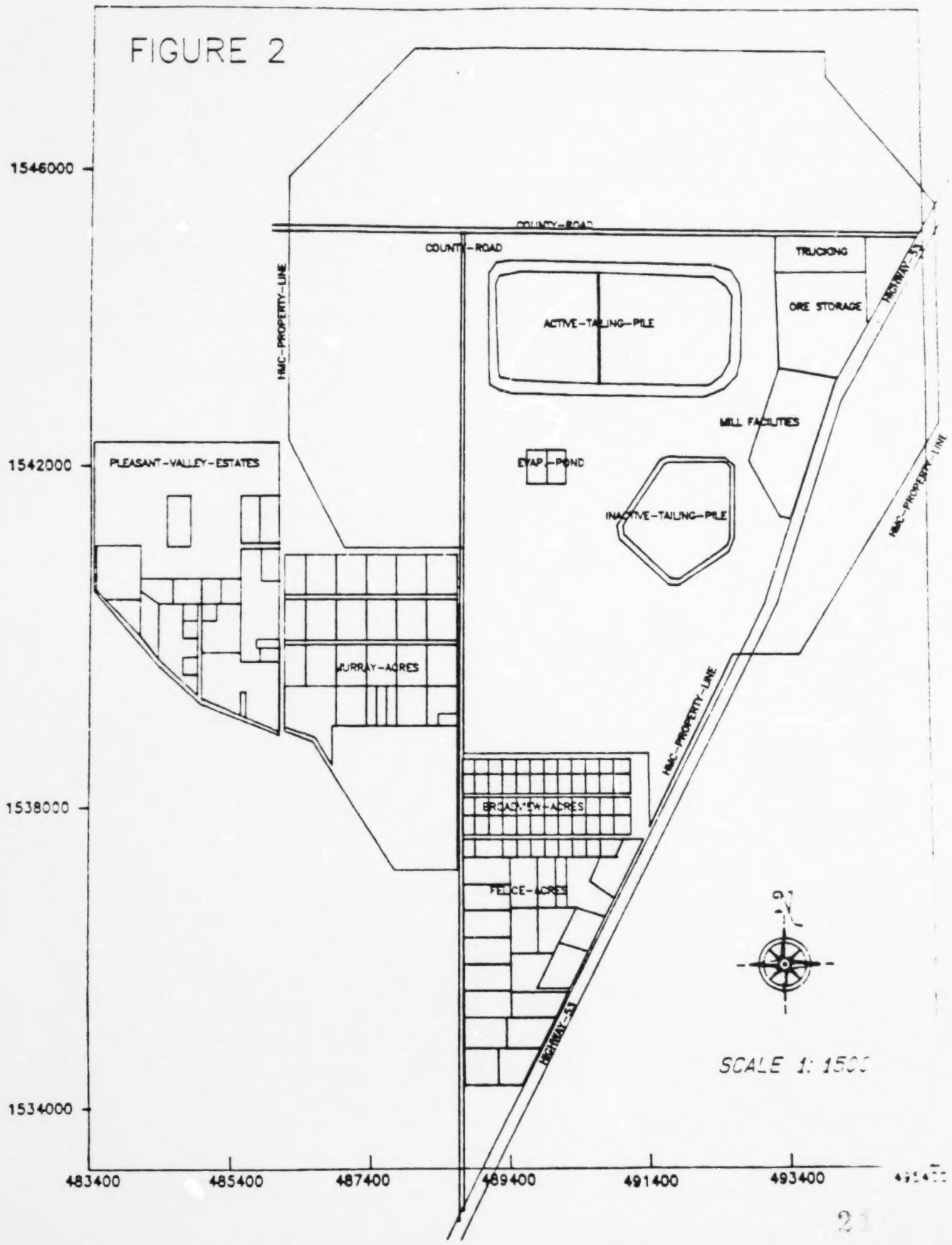
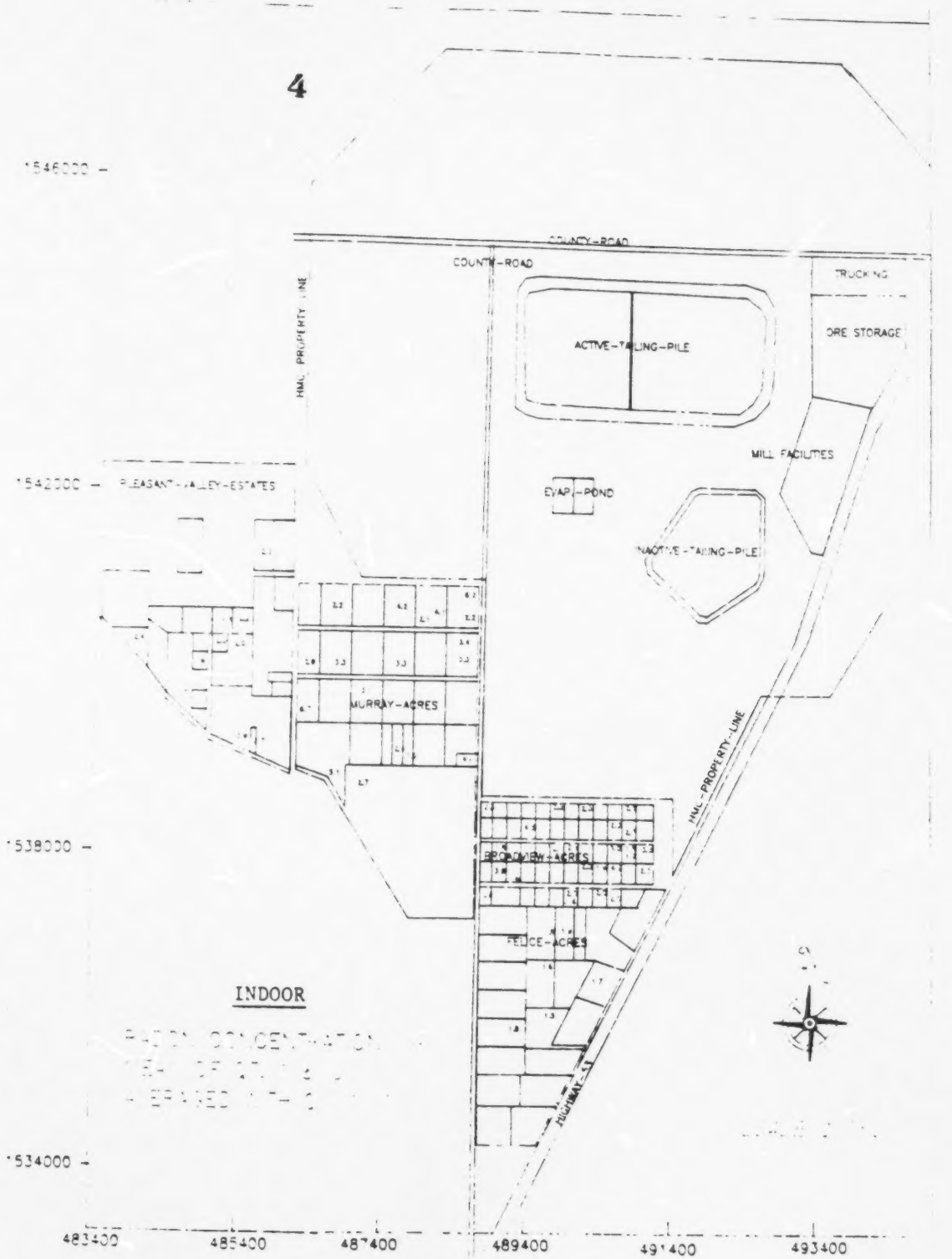


Figure 3. Map of Regional Area.


4
1546000
COUNTY-ROAD
COUNTY-ROAD
TRUCKING
HML PROPERTY LINE
ACTIVE-TAILING-PILE
ORE STORAGE
MILL FACILITIES
1542000
PLEASANT-VALLEY-ESTATES
EVAP.-POND
INACTIVE-TAILING-PILE
MURRAY-ACRES
HML-PROPERTY-LINE
1538000
BROADVIEW-ACRES
FELICE-ACRES
INDOOR
HIGHWAY 93
1534000
483400
485400
487400
489400
491400
493400

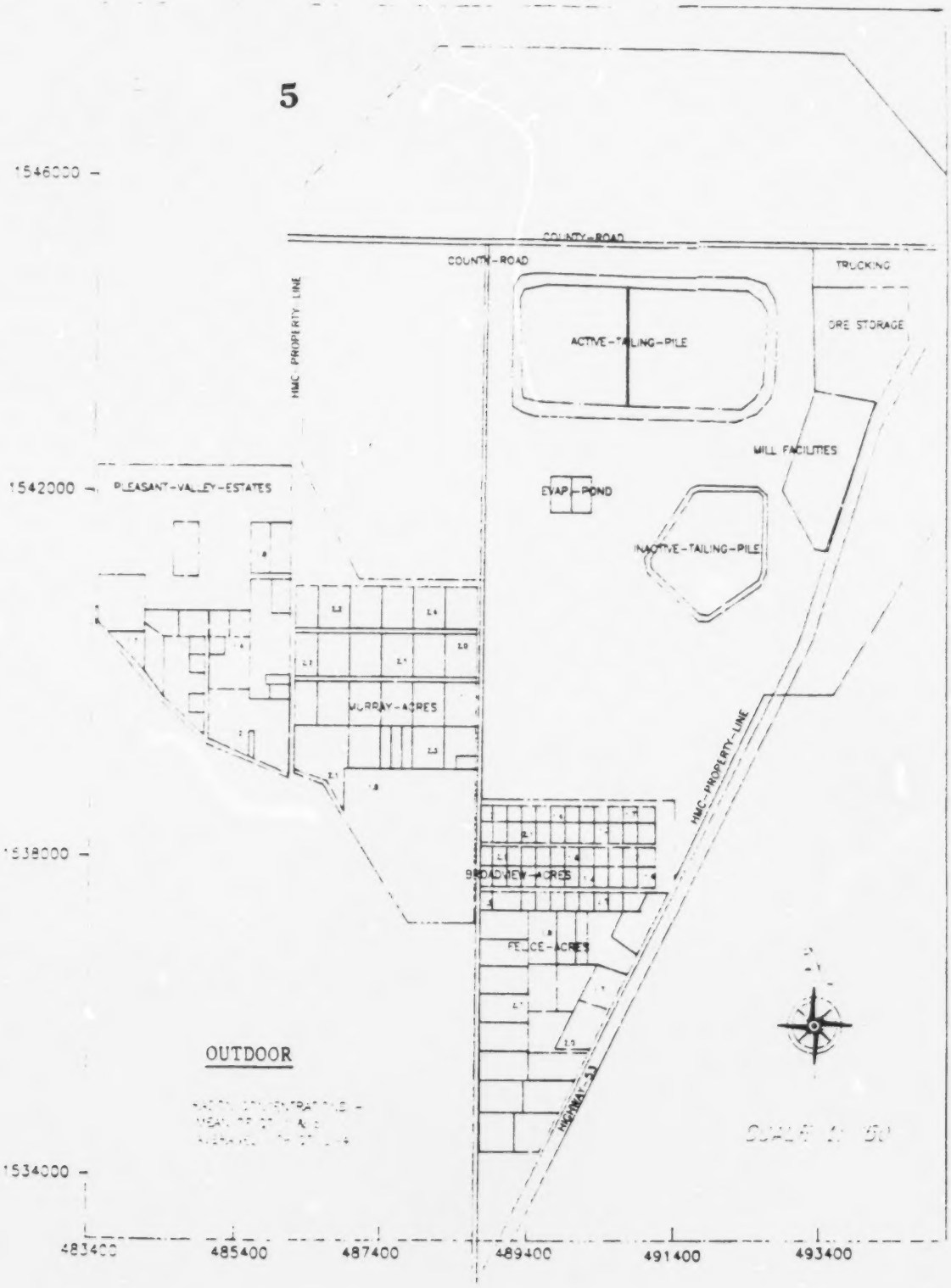

1546000
1542000
1538000
1534000
483400
485400
487400
489400
491400
493400
COUNTY-ROAD
COUNTY-ROAD
TRUCKING
HMC PROPERTY LINE
ACTIVE-TAILING-PILE
ORE STORAGE
MILL FACILITIES
EVAP-POND
INACTIVE-TAILING-PILE
PLEASANT-VALLEY-ESTATES
MURRAY-ACRES
BROADVIEW-ACRES
FENCE-ACRES
HMC-PROPERTY-LINE
OUTDOOR
SCALE 1" = 60'

FIGURE 6

PROBABILITY DISTRIBUTION OF CORRECTED INDOOR RADON CONCENTRATIONS
FOR 12-MONTH AVERAGES IN SUBDIVISION HOUSES

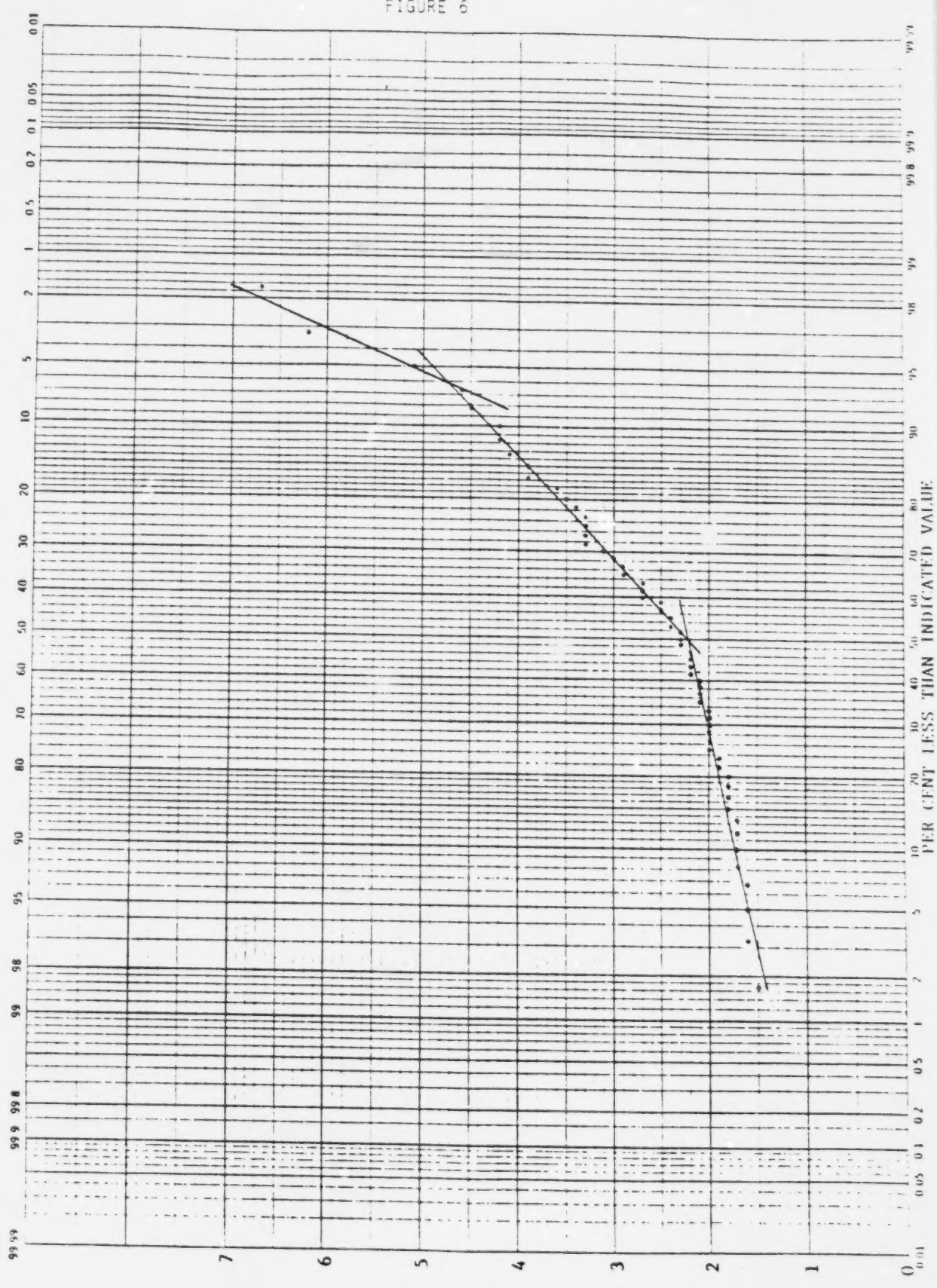


Table 1

[illegible] - BEARTS OPERATION
[illegible] RADON STUDY
INDOOR QUARTERLY RADON TRACK-ETCH CONCENTRATIONS

| LOCATION | EAST COORD | NORTH COORD | MEASURED: FIRST QT. SEDIMENTARY RN CONC PICO/L | MEASURED: SECOND QTR SEDIMENTARY RN CONC PICO/L | MEASURED: THIRD QT. SEDIMENTARY RN CONC PICO/L | MEASURED: FOURTH QTR SEDIMENTARY RN CONC PICO/L | MEASURED: AVERAGE FIRST & SEC. QT. RN CONC PICO/L | MEASURED: BASEMENT TYPE | CORRECTED: QT. 1&2 AVG QA ADJUSTED BY QT. | CORRECTED: QT. 1-3 AVG QA ADJUSTED BY QT. | CORRECTED: QT. 1-4 AVG QA ADJUSTED BY QT. | CORRECTED: QT. 2-4 AVG QA ADJUSTED BY QT. | CORRECTED: [illegible] AVG QA ADJUSTED BY QT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEACOFIELD ACRES | | | | | | | | | | | | | |
| B1-L22 | 488425 | 1538500 | 2.9 | 2.1 | 1.6 | 1.5 | 2.5 | 2.5 FRAME SLAB | 3.0 | 2.7 | 2.4 | 2.2 | 2.3 |
| B1-L12 | 489740 | 1538500 | 2.2 | 1.8 | 2.0 | 2.2 | 2.0 | 2.0 FRAME/CRAWL | 2.4 | 2.4 | 2.4 | 2.7 | 2.1 |
| B1-L9 | 490025 | 1538475 | 2.0 | 1.4 | 1.7 | 1.7 | 2.4 | 1.7 TRAILER | 2.1 | 2.0 | 2.0 | 2.1 | 2.1 |
| B1-L5 | 490825 | 1538475 | 1.5 | 1.3 | 1.7 | NA | 1.6 | 1.4 TRAILER | 1.7 | 1.8 | NA | NA | NA |
| B1-L2 | 490775 | 1538475 | 1.5 | 1.7 | 1.2 | 1.7 | 2.8 | 1.6 TRAILER | 1.9 | 1.8 | 1.8 | 2.4 | 2.1 |
| B1-L18 | 489450 | 1538238 | 4.9 | 4.2 | 3.2 | 2.2 | 6.8 | 4.6 FRAME/CRAWL | 5.5 | 4.9 | 4.3 | 4.8 | 4.5 |
| B1-L8/10 | 490075 | 1538225 | 1.8 | 1.6 | 1.5 | 1.0 | NA | 1.7 TRAILER | 2.1 | 2.0 | 1.8 | NA | NA |
| B1-L6 | 490600 | 1538225 | 2.1 | 1.8 | 2.1 | 1.6 | 2.5 | 2.0 FRAME/CRAWL | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 |
| B1-L4 | 490875 | 1538175 | 3.1 | 2.2 | 1.8 | 2.2 | 3.2 | 2.7 FRAME/CRAWL | 3.2 | 2.9 | 2.8 | 2.8 | 2.7 |
| B2-L21 | 489025 | 1538025 | 1.7 | 1.2 | 1.3 | 1.5 | 2.2 | 1.5 TRAILER | 1.8 | 1.7 | 1.7 | 1.8 | 1.8 |
| B2A-L20 | 488975 | 1537675 | 4.2 | 3.6 | 2.7 | 2.8 | 4.2 | 3.2 FRAME/SLAB | 4.7 | 4.2 | 4.0 | 3.9 | 3.8 |
| B2A-L18 | 489250 | 1537525 | 1.8 | 1.1 | 1.5 | 0.9 | 3.2 | 1.5 TRAILER | 1.8 | 1.8 | 1.6 | 1.7 | 1.8 |
| B2-L13 | 489950 | 1538025 | 2.2 | 1.9 | 1.6 | 1.5 | 2.5 | 2.1 TRAILER | 2.5 | 2.3 | 2.1 | 2.2 | 2.2 |
| B2-L11 | 490250 | 1538015 | 1.9 | 1.8 | 1.8 | 1.5 | 2.2 | 1.9 TRAILER | 2.2 | 2.2 | 2.1 | 2.1 | 2 |
| B2-L8 | 490625 | 1537950 | 2.9 | 2.2 | 1.8 | 1.5 | 4.4 | 2.1 FRAME/CRAWL | 3.8 | 3.2 | 2.8 | 2.6 | 2.6 |
| B2-L3 | 490775 | 1537925 | 2.0 | 1.7 | 1.2 | 1.2 | 2.2 | 1.9 TRAILER | 2.2 | 2.0 | 1.8 | 1.8 | 1.8 |
| B2-L3 | 490900 | 1537925 | 1.2 | 1.2 | 1.1 | 1.8 | 2.1 | 1.3 TRAILER | 1.6 | 1.5 | 1.6 | 1.9 | 1.7 |
| B2A-L10 | 490250 | 1537750 | 3.2 | 2.4 | 1.7 | 1.4 | 3.2 | 2.8 TRAILER | 3.4 | 2.9 | 2.6 | 2.6 | 2.5 |
| B2A-L6 | 490675 | 1537750 | 3.9 | 3.5 | 3.2 | 3.6 | 4.0 | 3.7 FRAME/CRAWL | 4.5 | 4.3 | 4.2 | 4.2 | 4.2 |
| B2A-L2 | 491025 | 1537700 | 2.5 | 2.0 | 1.4 | 2.0 | 2.7 | 2.2 TRAILER | 2.7 | 2.4 | 2.4 | 2.4 | 2.3 |
| B2A-L9 | 488825 | 1537425 | 2.9 | 2.1 | 2.7 | 2.1 | 3.0 | 2.5 FRAME/CRAWL | 3.0 | 3.1 | 2.9 | 2.8 | 2.8 |
| B2A-L5 | 489955 | 1537425 | 2.9 | 4.4 | 2.5 | 1.9 | 4.0 | 3.7 FRAME/SLAB | 4.4 | 3.9 | 3.5 | 3.8 | 3.8 |
| B2A-L2 | 490100 | 1537500 | 1.7 | 1.6 | 1.7 | 1.4 | 2.8 | 1.7 TRAILER | 2.0 | 2.0 | 1.9 | 2.2 | 2 |
| B2A-L1 | 490450 | 1537500 | 2.3 | 1.6 | 1.5 | 1.5 | 2.2 | 2.0 TRAILER | 2.4 | 2.2 | 2.1 | 2.2 | 2 |
| B4A-L2 | 490615 | 1537450 | 1.9 | 1.9 | 1.5 | 1.6 | 1.6 | 1.9 FRAME/SLAB | 2.2 | 2.1 | 2.1 | 1.9 | 2.1 |
| B2-L1 | 491125 | 1537950 | 3.0 | 3.6 | 2.5 | 2.2 | 4.0 | 3.3 FRAME/CRAWL | 4.0 | 3.7 | 3.4 | 3.6 | 3.4 |
| B2A-L3 | 490225 | 1537925 | 1.3 | 2.0 | 2.0 | 1.0 | 1.5 | 1.7 TRAILER | 2.0 | 2.1 | 1.9 | 1.9 | |
| PELICE ACRES | | | | | | | | | | | | | |
| PA-2 | 489725 | 1536875 | 2.2 | 1.5 | 1.2 | 1.3 | 2.2 | 1.9 TRAILER | 2.2 | 2.0 | 1.9 | 2 | |
| PA-4 | 489745 | 1536625 | 1.4 | 1.5 | 1.4 | 0.8 | 1.8 | 1.5 TRAILER | 1.8 | 1.7 | 1.5 | 1.5 | 1 |
| PA-6 | 489325 | 1536225 | 2.2 | 1.5 | 1.4 | 1.3 | 1.7 | 1.9 TRAILER | 2.2 | 2.0 | 1.9 | 1.9 | |
| PA-5 | 490050 | 1536425 | 2.2 | 1.3 | 0.9 | 1.3 | 2.6 | 1.8 TRAILER | 2.1 | 1.8 | 1.7 | 1.8 | 1 |
| PA-5 | 490425 | 1536375 | 1.5 | 1.1 | NA | NA | 2.1 | 1.3 TRAILER | 1.6 | NA | NA | NA | NA |
| PA-7 | 489965 | 1536825 | 2.6 | 1.7 | 1.7 | 1.2 | 1.5 | 2.2 TRAILER | 2.6 | 2.4 | 2.2 | 1.9 | 2 |
| PA-8 | 489775 | 1536075 | 1.5 | 1.1 | 1.1 | 1.0 | 2.4 | 1.3 TRAILER | 1.6 | 1.5 | 1.4 | 1.5 | 1.5 |
| MURRAY ACRES | | | | | | | | | | | | | |
| B1-L3 | 486900 | 1540700 | 2.6 | 1.7 | 1.8 | 1.8 | 2.0 | 2.2 TRAILER | 2.6 | 2.4 | 2.4 | 2 | 2.1 |
| B1-L1 | 487600 | 1540725 | 5.4 | 3.6 | 3.6 | 1.8 | 5.6 | 4.5 FRAME/CRAWL | 5.5 | 5.1 | 4.2 | 4.2 | 4.2 |
| B1-L2 | 488100 | 1540725 | 4.1 | 2.8 | 3.3 | 3.6 | 4.5 | 3.4 FRAME/CRAWL | 4.2 | 4.1 | 4.1 | 4.2 | 4 |
| B1-L7 | 486550 | 1541025 | 5.3 | 5.7 | 6.8 | 3.0 | 6.1 | 5.5 FRAME/SLAB | 6.7 | 7.1 | 6.2 | 6.4 | 6.7 |
| B1-L1 | 488570 | 1540725 | 3.6 | 1.1 | 1.2 | 1.9 | 3.4 | 2.4 TRAILER | 2.8 | 2.4 | 2.2 | 2.2 | 2 |
| B2-L5 | 486300 | 1540125 | 2.2 | 2.5 | 2.4 | 1.6 | 4.6 | 2.4 FRAME/CRAWL | 2.9 | 2.8 | 2.6 | 2.2 | 2 |
| B2-L5 | 486750 | 1540150 | 3.8 | 3.0 | 2.6 | 2.1 | 3.4 | 3.4 FRAME/CRAWL | 4.1 | 3.8 | 3.4 | 2.2 | 2 |

Table 1 (cont'd)

| | | | MEASURED | | | | | | CORRECTED | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B2-L3 | 48°550 | 1540125 | 2.4 | 2.2 | 2.0 | 1.8 | 4.2 | 2.9 FRAME/CRAWL | 2.4 | 2.4 | 2.1 | 2.5 | 2.2 |
| B2-L' | 488550 | 1540225 | 2.1 | 2.3 | 2.2 | 2.3 | 2.3 | 2.2 TRAILER | 2.6 | 2.5 | 2.5 | 2.2 | 2.4 |
| B2-L2 | 488550 | 1540275 | 2.4 | 2.0 | 2.5 | 2.4 | 4.2 | 2.7 FRAME/CRAWL | 2.2 | 2.2 | 2.1 | 2.5 | 2.2 |
| B2-L6 | 488250 | 1539975 | 6.6 | 8.5 | 7.9 | 7.2 | 4.0 | 8.1 FRAME/CRAWL | 9.8 | 8.1 | 7.2 | 6.1 | 6.7 |
| B2-L4 | 487800 | 1539775 | 2.4 | 2.4 | 2.5 | 2.2 | 2.2 | 2.3 TRAILER | 2.5 | 2.2 | 2.2 | 2.1 | 2.1 |
| B4-L5 | 488700 | 1539825 | 5.1 | 5.4 | 3.8 | 3.0 | 5.2 | 5.2 FRAME/CRAWL | 6.4 | 5.7 | 5.2 | 5.1 | 5.1 |
| B4-L2C | 487550 | 1539025 | 2.5 | 2.2 | 1.9 | 2.1 | 2.1 | 2.4 TRAILER | 2.9 | 2.4 | 2.4 | 2.5 | 2.4 |
| B4-L2D | 487125 | 1539045 | 3.3 | 2.2 | 2.5 | 2.0 | 2.8 | 2.7 FRAME/SLAB | 3.2 | 2.2 | 2.2 | 2.5 | 2.2 |
| B4-L2 | 488075 | 1539075 | 2.2 | 1.7 | 1.5 | 1.0 | NA | 2.0 FRAME/CRAWL | 2.4 | 2.2 | 1.9 | NA | NA |
| B4-L2A | 488540 | 1539025 | 4.0 | 3.6 | 3.5 | 4.5 | 3.9 | 3.8 FRAME/SLAB | 4.6 | 4.5 | 4.7 | 4.5 | 4.5 |
| B4-L2 | 487850 | 1540675 | 2.4 | 1.4 | 1.8 | 1.4 | 2.9 | 1.9 TRAILER | 2.2 | 2.2 | 2.1 | 2.2 | 2.1 |
| B4-L5 | 487150 | 1538775 | 3.0 | 2.4 | 2.2 | 1.1 | 4.0 | 2.7 FRAME/SLAB | 3.2 | 2.1 | 2.5 | 2.2 | 2.7 |
| PLEASANT VALLEY | | | | | | | | | | | | | |
| L13 | 485700 | 1541225 | 1.8 | 1.6 | 2.0 | 1.7 | 2.7 | 1.7 TRAILER | 2.1 | 2.2 | 2.1 | 2.2 | 2.2 |
| L2 | 484000 | 1540275 | 2.1 | 1.5 | 2.2 | 2.2 | 2.5 | 1.8 FRAME, BASEMENT | 2.2 | 2.2 | 2.4 | 2.5 | 2.4 |
| L7 | 484550 | 1539775 | 1.4 | 1.1 | 1.2 | 1.9 | 1.8 | 1.2 TRAILER | 1.5 | 1.5 | 1.7 | 1.8 | 1.7 |
| L9 | 484500 | 1539775 | NA | NA | NA | 1.5 | 2.0 | NA FRAME/CRAWL | NA | NA | NA | NA | NA |
| L5 | 484800 | 1539675 | 2.1 | 2.1 | 1.6 | 1.8 | NA | 2.1 TRAILER | 2.6 | 2.2 | 2.2 | NA | NA |
| L6 | 484850 | 1540425 | 2.9 | 1.4 | NA | NA | 2.6 | 2.2 TRAILER | 2.6 | 1.7 | NA | NA | NA |
| L5 | 484380 | 1540125 | 1.5 | 0.8 | 1.2 | 1.5 | 2.4 | 1.2 TRAILER | 1.4 | 1.4 | 1.5 | 1.7 | 1.5 |
| L9 | 485100 | 1540200 | 2.2 | 1.6 | 1.6 | 1.2 | 2.7 | 2.0 TRAILER | 2.4 | 2.2 | 2.2 | 2.1 | 2.1 |
| L10 | 485120 | 1540575 | 2.2 | 1.2 | 1.5 | 1.2 | 1.8 | 1.7 TRAILER | 2.1 | 2.0 | 1.8 | 1.5 | 1.7 |
| L11 | 485220 | 1540575 | 2.7 | 1.4 | 2.0 | 1.6 | 2.2 | 2.1 TRAILER | 2.5 | 2.4 | 2.2 | 2.1 | 2.2 |
| L12 | 485400 | 1540220 | 2.5 | 1.4 | 1.4 | 1.5 | 2.4 | 2.0 TRAILER | 2.4 | 2.1 | 2.0 | 2.2 | 2.1 |
| L7 | 485600 | 1539125 | 2.7 | 2.4 | 1.7 | 1.7 | 2.9 | 2.6 FRAME/CRAWL | 3.1 | 2.7 | 2.5 | 2.8 | 2.7 |
| L18 | 485475 | 1539175 | 2.7 | 2.9 | 4.9 | 1.8 | 3.5 | 3.2 FRAME/CRAWL | 4.0 | 4.5 | 4.2 | 2.8 | 3.2 |

BA B1-L5: RESIDENT UNAVAILABLE END OF 4TH QUARTER, 5TH QT. RESULTS COVER 4TH & 5TH QUARTERS
BA B1-L8/10: RESIDENT MOVED DURING 5TH QUARTER, MONITOR LOST
BA-6 ORIGINAL RESIDENT MOVED, LOST DETECTORS FOR 3RD & 4TH QUARTER
BA B4-L3: RESIDENT OUT OF AREA DURING LAST QUARTER, DETECTOR LOST
PP-L7: HOUSE MOVED INTO LOT DURING 3RD QUARTER RESULTS FOR 4TH AND 5TH QUARTERS ONLY
PP-L5: TRAILER REMOVED FROM LOT DURING 5TH QUARTER. DETECTOR LOST
PP-L5: ORIGINAL RESIDENT MOVED, LOST DETECTORS FOR 3RD & 4TH QUARTERS

Table 2

HOMESTAKE MINING COMPANY - GRANTS OPERATION
SUBSITE SIGNS RADON STUDY
OUTDOOR QUARTERLY TRACK-ETCH RADON CONCENTRATIONS

MEASURED / CORRECTED /

| LOCATION | EAST COORD | NORTH COORD | FIRST QT SEC. QT RN CONC PIC/L | SECOND QT SEC. QT RN CONC PIC/L | THIRD QT SEC. QT RN CONC PIC/L | FOURTH QT SEC. QT RN CONC PIC/L | FIFTH QT SEC. QT RN CONC PIC/L | FIRST QT. AVG PIC/L | 1ST QT. ADJUSTED BY QT. | 1-2 QT. AVG QA ADJUSTED BY QT. | 1-3 QT. AVG QA ADJUSTED BY QT. | 1-4 QT. AVG QA ADJUSTED BY QT. | 2-5 QT. AVG QA ADJUSTED BY QT. | 3-5 QT. AVG QA PLUS QT 3-4 ADJUSTED BY QT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BA B1-C03 | 488825 | 1538490 | 3.0 | 1.5 | 4.0 | 1.8 | 3.4 | 3.0 | 1.5 | 1.7 | 1.6 | 1.9 | 1.7 | |
| BA B1-C13 | 487581 | 1538530 | 1.0 | 1.1 | 2.4 | 1.1 | 4.7 | 1.7 | 1.1 | 1.2 | 1.1 | 1.8 | 1.4 | |
| BA B1-C0 | 490785 | 1538475 | 1.7 | 1.7 | 1.4 | 1.9 | 6.9 | 1.7 | 1.0 | 0.9 | 1.1 | 2.4 | 1.7 | |
| BA B1-C19 | 489450 | 1538230 | 3.9 | 3.9 | 4.1 | 2.0 | 3.8 | 3.4 | 3.1 | 3.2 | 3.0 | 3.2 | 3.1 | |
| BA B1-C8 | 490285 | 1538225 | 3.8 | 1.3 | 2.7 | 1.0 | 2.8 | 2.1 | 1.4 | 1.4 | 1.2 | 1.6 | 1.2 | |
| BA B2-C21 | 489025 | 1538015 | 3.5 | 3.2 | 3.6 | 2.0 | 5.9 | 3.9 | 1.7 | 1.6 | 1.6 | 2.5 | 2.1 | |
| BA B2-C11 | 490085 | 1538005 | 2.3 | 2.9 | 2.8 | 1.0 | 3.9 | 2.6 | 1.5 | 1.5 | 1.3 | 1.8 | 1.6 | |
| BA B2-C2 | 491775 | 1537915 | 2.6 | 2.7 | 2.4 | 2.5 | 6.0 | 2.7 | 1.5 | 1.5 | 1.2 | 2.2 | 1.7 | |
| BA B2A-C1 | 490240 | 1537750 | 1.2 | 1.7 | 1.7 | 1.2 | 3.4 | 1.5 | 0.9 | 0.9 | 0.9 | 1.5 | 1.2 | |
| BA B2A-C2 | 491005 | 1537690 | 2.3 | 2.5 | 1.7 | 0.8 | 2.7 | 2.8 | 1.7 | 1.4 | 1.2 | 1.6 | 1.4 | |
| BA B2A-C3 | 489825 | 1537425 | 2.4 | 1.9 | 2.6 | 1.6 | 4.8 | 2.7 | 1.7 | 1.6 | 1.5 | 2.0 | 1.8 | |
| BA B2A-C1 | 490460 | 1537600 | 2.3 | 2.2 | 1.7 | 1.9 | 7.6 | 2.6 | 1.6 | 1.4 | 1.4 | 2.7 | 2.0 | |
| FA-C2 | 489725 | 1536865 | 2.2 | 1.6 | 2.2 | 1.9 | 5.6 | 2.0 | 1.2 | 1.4 | 1.4 | 2.2 | 1.9 | |
| FA-C6 | 489225 | 1536215 | 4.3 | 5.1 | 4.3 | 1.7 | 7.4 | 4.6 | 2.7 | 2.5 | 2.2 | 3.2 | 2.7 | |
| FA-C5 | 490250 | 1536415 | 2.8 | 3.2 | 3.2 | 1.2 | 3.9 | 2.7 | 1.5 | 1.6 | 1.4 | 2.0 | 1.7 | |
| FA-C7 | 489365 | 1535815 | 1.5 | 2.7 | 4.2 | 1.6 | 5.2 | 2.1 | 1.2 | 1.6 | 1.5 | 2.4 | 2.0 | |
| MA B1-C5 | 488800 | 1540650 | 1.9 | 4.0 | 3.6 | 1.5 | 6.5 | 3.0 | 1.6 | 1.7 | 1.6 | 2.8 | 2.2 | |
| MA B1-C2 | 488110 | 1540725 | 3.3 | 2.4 | 3.4 | 2.5 | 5.9 | 2.9 | 1.8 | 1.8 | 2.0 | 2.9 | 2.4 | |
| MA B2-C6 | 488210 | 1540125 | 6.8 | 1.1 | 3.7 | 1.2 | 5.7 | 4.0 | 2.8 | 2.5 | 2.1 | 3.2 | 2.8 | |
| MA B2-C3 | 487640 | 1540125 | 3.0 | 3.2 | 5.6 | 1.8 | 6.2 | 2.7 | 1.7 | 2.3 | 2.1 | 3.0 | 2.5 | |
| MA B2-C1 | 488540 | 1540275 | 4.0 | 2.3 | 4.2 | 1.1 | 5.1 | 3.2 | 2.0 | 2.1 | 1.8 | 2.3 | 2.0 | |
| MA B4-C5 | 486700 | 1539815 | 3.9 | 1.9 | 5.7 | 1.6 | 4.1 | 2.9 | 1.9 | 2.3 | 2.3 | 3.2 | 2.1 | |
| MA B4-C2 | 488265 | 1539275 | 4.8 | 3.1 | 4.7 | 1.1 | 8.1 | 3.5 | 2.3 | 2.4 | 2.0 | 3.0 | 2.5 | |
| MA B4-C5 | 487150 | 1539755 | 3.4 | 1.8 | 4.0 | 1.2 | 4.2 | 2.6 | 1.7 | 1.8 | 1.6 | 2.0 | 1.8 | |
| PP-C12 | 485700 | 1541225 | 2.4 | 1.5 | 1.2 | 1.6 | 8.2 | 2.0 | 1.2 | 1.0 | 1.1 | 2.6 | 1.8 | |
| PP-C2 | 484200 | 1540265 | 3.5 | 3.8 | 2.1 | 1.0 | 5.1 | 3.2 | 2.0 | 1.7 | 1.5 | 2.3 | 1.7 | |
| PP-C10 | 485400 | 1540210 | 1.5 | 1.2 | 2.9 | 1.2 | 3.9 | 1.4 | 0.8 | 1.1 | 1.0 | 1.7 | 1.4 | |
| PP-C18 | 485465 | 1539175 | 2.9 | 1.2 | 1.3 | 1.4 | 3.3 | 2.0 | 1.3 | 1.1 | 1.1 | 1.4 | 1.2 | |
| | | | | | | | | | | | | | | |
| AVERAGE | | | | | | | | 1.6 | 1.6 | 1.5 | 2.2 | 1.9 | | |

TABLE 3

SUMMARY OF CORRECTED INDOOR RADON LEVELS (pCi/l)
BY QUARTERLY AVERAGES AND SUBDIVISIONS

| SUBDIVISION | QUARTERLY AVERAGE RADON CONCENTRATION, pCi/l | | | | |
|---|---|---|---|---|---|
| | 1 - 2 | 1 - 3 | 1 - 4 | 2 - 5 | 1 & 5 - 2 - 4[a] |
| Broadview Acres | 2.8 (27)[b] | 2.6 (27) | 2.5 (26) | 2.6 (25) | 2.5 (25) |
| Felice Acres | 2.0 ( 7) | 1.9 ( 6) | 1.8 ( 6) | 1.7 ( 6) | 1.7 ( 6) |
| Murray Acres | 4.1 (19) | 3.8 (19) | 3.6 (19) | 3.7 (18) | 3.6 (18) |
| Pleasant Valley Estates | 2.4 (12) | 2.3 (12) | 2.2 (11) | 2.3 (10) | 2.2 (10) |
| Corrected Total Average | 3.0 (65) | 2.8 (64) | 2.7 (62) | 2.8 (59) | 2.7 (59)[c] |

a The values in this column were calculated by averaging the values for the 1st and 5th quarters and using this average (representing a weighted 1st quarter) to then average with quarters 2 - 4.

b The numbers in parentheses represent the number of measurements.

c This value is the twelve-month average radon level in pCi/l for the 59 residences studied in the four subdivisions.

TABLE 4

SUMMARY OF CORRECTED OUTDOOR RADON LEVELS (pCi/l)
BY QUARTERLY AVERAGES

| PARAMETER | QUARTERLY AVERAGE RADON CONCENTRATION, pCi/l | | | | |
|---|---|---|---|---|---|
| | 1 - 2 | 1 - 3 | 1 - 4 | 2 - 5 | 1 & 5 + 2 - 4[a] |
| Corrected Total Average | 1.6 | 1.6 | 1.5 | 2.2 | 1.9[b] |
| Number of Measurements | 28 | 28 | 28 | 28 | 28 |

a The values in this column were calculated by averaging the values for the 1st and 5th quarters and using this average (representing a weighted 1st quarter) to then average with quarters 2 - 4.

b This value is the twelve-month average radon level in pCi/l for the 28 outdoor monitoring stations studied in the four subdivisions.

TABLE 5

INDOOR RADON CONCENTRATIONS
(CORRECTED TWELVE-MONTH AVERAGES IN pCi/l)
FOR FRAME HOUSES AND TRAILERS

| SUBDIVISION | FRAME HOUSES | | TRAILERS | |
|---|---|---|---|---|
| | Radon (pCi/l) | Number | Radon (pCi/l) | Number |
| Broadview Acres | 3.1 | 12 | 2.0 | 13 |
| Felice Acres[a] | -- | -- | 1.7 | 6 |
| Murray Acres | 4.0 | 12 | 2.6 | 6 |
| Pleasant Valley Estates | 3.0 | 3 | 1.9 | 7 |
| All Subdivisions | 3.6 | 27 | 2.0 | 32 |

a Felice Acres contains only trailers.

TABLE 6

INDOOR CORRECTED RADON CONCENTRATIONS (12-MONTH AVERAGES)
BASED ON GENERAL CONSTRUCTION TYPE AND
QUALITY OF RESIDENCE

| RADON PROBABILITY GROUP, pCi/l | TOTAL NUMBER OF RESIDENCES | NUMBER OF FRAME/CRAWL | NUMBER OF FRAME/SLAB | NUMBER OF TRAILERS |
|---|---|---|---|---|
| 1.5 - <2.2 | 24 | 0 | 1[a] | 23 |
| ≥2.2 - 4.7 | 32 | 17[b] | 6 | 9[c] |
| ≥4.7 - 6.7 | 3 | 2 | 1 | 0 |
| Totals | 59 | 19 | 8 | 32 |
| ≥4.0 - 6.7 | 8 | 6 | 2 | 0 |

a The lowest indoor radon level in a house is 2.0 pCi/l.

b This includes one house with a basement.

c The highest indoor radon level in a trailer is 3.4 pCi/l.

TABLE 7

COMPARISON OF INDOOR AND OUTDOOR CORRECTED RADON CONCENTRATIONS

| SUBDIVISION | TYPE RESIDENCE | OUTDOOR RADON, pCi/l[a] | INDOOR/ OUTDOOR[a] | INDOOR RADON, pCi/l[a] |
|---|---|---|---|---|
| Pleasant Valley Estates | Frame/Crawl | 1.2 | 3.25 | 3.9 |
| Murray Acres | Frame/Crawl | 2.1 | 2.43 | 5.1 |
| Broadview Acres | Frame/Crawl | 2.1 | 2.14 | 4.5 |
| Broadview Acres | Trailer | 1.2 | 2.08 | 2.5 |
| Murray Acres | Frame/Crawl | 1.4 | 1.79 | 2.5 |
| Murray Acres | Frame/Crawl | 2.4 | 1.71 | 4.1 |
| Broadview Acres | Frame/Crawl | 2.0 | 1.65 | 3.3 |
| Broadview Acres | Trailer | 1.4 | 1.64 | 2.3 |
| Murray Acres | Frame/Crawl | 1.8 | 1.61 | 2.9 |
| Pleasant Valley Estates | Frame/Slab | 1.8 | 1.50 | 2.7 |
| Pleasant Valley Estates | Trailer | 1.4 | 1.43 | 2.0 |
| Broadview Acres | Frame/Basement | 1.7 | 1.41 | 2.4 |
| Murray Acres | Frame/Slab | 1.7 | 1.35 | 2.3 |
| Murray Acres | Frame/Crawl | 2.2 | 1.32 | 2.9 |
| | Frame/Crawl | 2.5 | 1.32 | 3.3 |
| Broadview Acres | Trailer | 1.6 | 1.31 | 2.1 |
| Broadview Acres | Trailer | 1.7 | 1.24 | 2.1 |
| Pleasant Valley Estates | Trailer | 1.8 | 1.22 | 2.2 |
| Broadview Acres | Trailer | 1.7 | 1.06 | 1.8 |
| Broadview Acres | Trailer | 2.0 | 1.00 | 2.0 |
| Felice Acres | Trailer | 1.8 | 1.00 | 1.9 |
| Felice Acres | Trailer | 1.7 | 1.00 | 1.7 |
| Murray Acres | Trailer | 2.2 | 1.00 | 2.2 |
| Felice Acres | Trailer | 2.0 | 0.95 | 1.9 |
| Broadview Acres | Trailer | 2.1 | 0.86 | 1.8 |
| Felice Acres | Trailer | 2.7 | 0.67 | 1.8 |

a The values used are the 12-month averages calculated by averaging the 1st and 5th quarters and using this value to average with the 2nd, 3rd, and 4th quarters.

TABLE 8

Prioritized Listing of House Specific Remedial Measures for Reducing Indoor Radon Concentrations

| House No. | Location | Increased Crawl Space Ventilation | High Efficiency Forced-Air Heating | Seal Cracks and Openings in floor | Other |
|---|---|---|---|---|---|
| 1 | MA B1-L1 | | 2 | 3 | 1) Concrete Slab (brdm) w/wooden floor above<br>4) Window fan |
| 2 | MA B1-L2 | 1 | 3 | 2 | 4) Increase Crawl Space Depth |
| 3 | MA B1-L3 | 1 | 4 | 2 | 3) Attic Fan |
| 6 | MA B3-L6 | 1 | | 2 | 3) Forced-air ventilate crawl space<br>4) Attic fan |
| 7 | MA B4-L1A | | 4 | 2 | 1) Air Conditioning and ventilation in winter<br>3) Window Fans |
| 8 | BA B1-L18 | 1 | 5 | 2 | 3) Increase crawl space depth.<br>4) Forced ventilation of crawl space |
| 9 | BA B2A-L6 | 1 | 4 | 2 | 3) Increase crawl space depth<br>5) Forced ventilation of crawl space |
| 10 | MA B4-L5 | (owner declined to be included in survey) | | | |

TABLE 8
(continued)

Milan, New Mexico Homestake Mill Area
Recommendations for Modifications to Residences to Reduce Radon Concentration.

| House No. | Recommendation |
|---|---|
| Murray Acres | |
| 1. | Pour concrete slab in bedroom and construct wooden floor above slab. Use forced air heating in winter and natural ventilation in warm weather. |
| 2. | Install vents on all four walls of crawl space. |
| 3. | Open vents on south wall and install vents on east and west walls of crawl space. |
| 6. | Install additional vents on east and west walls of crawl space. |
| 7. | Residence has duct for evaporative air conditioner. Install air conditioner and provide increased ventilation in winter. |
| Broadview Acres | |
| 8. | Install vents on all four walls of crawl space. |
| 9. | Install vents on all four walls of crawl space. |

TABLE 8

(continued)

Milan, New Mexico Homestake Mill Area
Additional Recommendations for Reducing Radon Concentrations in Residences

| House Number | Recommendation |
|---|---|
| **Murray Acres** | |
| 1. | Install high efficiency forced-air heating system, Seal all cracks and openings in concrete slabs particularly around water and drain pipes. Install window fan to increase ventilation in warmer weather. |
| 2. | Seal around all pipes and close any other openings between crawl space and residence. Provide forced-air ventilation of crawl space. If possible, increase depth of crawl space. Install gunite or concrete slab on floor of crawl space. |
| 3. | Seal around all pipes and close any other openings entering residence from crawl space. Install attic fan to enhance air flow during warmer weather. Provide forced-air ventilation of crawl space. Provide forced-air ventilation in conjunction with heating system. |
| 6. | Seal around all pipes and close any other openings entering residence from crawl space. Provide forced-air ventilation of crawl space. Place gunite or concrete slab on floor of crawl space. Install attic fan to improve air circulation in warmer weather. |
| 7. | Seal all cracks and openings in concrete slabs particularly around water and drain pipes. Install window fans to improve ventilation during warmer weather. Install forced-air heating system. |
| **Broadview Acres** | |
| 8. | Seal around all pipes and close all openings between residence and crawl space. If possible, increase depth of crawl space. Provide forced-air ventilation of crawl space. Place gunite or concrete slab on floor of crawl space. Install high efficiency forced-air heating system. Provide forced-air ventilation of crawl space. |
| 9. | Seal around all pipes and close all openings betweed residence and crawl space. If possible, increase depth of crawl space. Place gunite or concrete slab on floor of crawl space. Install high efficiency forced-air heating system. Provide forced-air ventilation of crawl space. |

## REFERENCES


ICRP, 1987. Lung Cancer Risk from Indoor Exposure to Radon Daughters. ICRP Publication 50, Annals of the ICRP 17 (1).

Feasibility Study Report, June 1989. Grants, New Mexico Subdivisions Radon Study, Homestake Mining Company, Grants Operation.

NAS, 1988. Health Risks of Radon and Other Internally Deposited Alpha-Emitters: BEIR IV. Committee on the Biological Effects of Ionizing Radiations, National Research Council, National Academy of Sciences, Washington, D.C.

NCRP, 1984. Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States. NCRP Report No. 78, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Remedial Investigation Report, June 1989. Grants, New Mexico Subdivisions Radon Study, Homestake Mining Company, Grants Operation.

UNSCEAR, 1988. Source, Effects and Risks of Ionizing Radiation. United Nations, New York.

# Appendix A

## EVALUATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Appendix A

EVALUATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

INTRODUCTION

Section 121(d)(2) of CERCLA as amended in 1986 by SARA requires that the selected remedy attain certain requirements adopted under Federal and State environmental laws. These requirements are called "ARARs" or "applicable or relevant and appropriate requirements".

The Feasibility Study for the Homestake Mining Company Radon Operable Unit included a review of these laws, and identified those which could be ARARs based on the types of wastes and concentrations and sources of radon at the site. This appendix lists all the laws which the Feasibility Study identified as potential ARARs for the site.

EPA Guideline of 4 pCi/l (Indoor Radon)

The 4 pCi/l indoor exposure level is not a regulatory requirement but a guideline. EPA's radon guidance states that where indoor radon concentrations range from 4 pCi/l to 20 pCi/l, homeowners should undertake action to lower levels to 4 pCi/l or below within a few years, or sooner if levels are at the upper end of this range.

10 CFR Part 20, Standards for Protection Against Radiation

These regulations are considered ARARs. They are promulgated and enforced by the NRC and create standards for protection against radiation exposure which apply to all facilities licensed pursuant to the Atomic Energy Act. These regulations limit the concentration of radon-222 to 3 pCi/l above background at the boundary of HMC's property (a "restricted area"). The NRC license and regulations are designed to ensure achievement of this applicable maximum permissible concentration limit for exposure to individuals off-site of HMC facility.

Regulations in 10 CFR Part 20 give the NRC authority to limit a licensee's radon emissions to 1 pCi/l above background at the facility boundary. This limit is considered relevant and appropriate and it is within NRC's regulatory authority to enforce this concentration limit.

10 CFR Part 40, Appendix A, Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings of Wastes Produced by the Extraction or Concentration of Source Material from Ores Processes Primarily for Their Source Material Content

These regulations, established by NRC, govern the operation and decommissioning of licensed uranium mills and tailings piles, and are considered applicable or relevant and appropriate for mill closure. They specifically address clean-up standards for Ra-226 in soil, and involve the removal of Ra-226 contaminated soil in areas impacted by wind blown tailings. These regulations also require active mitigation of airborne emissions during operation, particularly particulates, by wetting or partially covering the tailings pile.

40 CFR Part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

EPA has established these standards under the authority of the Atomic Energy Act and the Uranium Mill Tailings Radiation Control Act for clean-up of land and buildings. They are considered relevant and appropriate in that they relate to reduction of radon concentrations in any occupied or habitable building to 4 pCi/l (or 0.02 WL, equivalent to EPA's radon action guideline), as well as to establishing a soil clean-up standard for radium.

State of New Mexico ARARs

The State uses EPA's recommended action level of 4 pCi/l for indoor radon, and the airborne concentration limits in 10 CFR Part 20. Other requirements conform with Federal regulations.

# APPENDIX B

## AGENCY FOR TOXIC SUBSTANCES AND DISEASE CONTROL (ATSDR)/ CENTER FOR DISEASE CONTROL (CDC) EVALUATION

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

MEMORANDUM

Date : September 15, 1989

From : Senior Regional Representative
ATSDR/Region VI

To : William D. Rowe, RPM
6H-EO

Subject: Health Consultation - Homestake Mining Company
Cibrola County, New Mexico

The Agency for Toxic Substances and Disease Registry (ATSDR) has been requested to review and comment on the proposed remedial decision identified by EPA in the draft ROD document (September 1989) for the Radon Operable Unit, Homestake Mining Company (HMC), Cibrola County, New Mexico.

BACKGROUND

ATSDR and the Center for Environmental Health, Centers for Disease Control (CDC) have previously had the opportunity to review and comment upon various aspects of the radon sampling program in the four subdivisions southwest of the HMC mill and tailings embankment areas. Most recently, the ATSDR Preliminary Health Assessment for Homestake (dated August 12, 1988) in discussing the off-site radon concern reiterated the CDC 1984 recommendation that all homes in the affected community should be included in the indoor monitoring program.

Other recommendations from previous reviews of site related documents have identified the need:

- to determine whether or not preliminary data on indoor radon concentrations were really above what might be typical from background in this region of the country, and

- to consider the influence of housing construction on radon build-up when designing the study.

FINDINGS

Areas of previous concern to ATSDR were addressed and summarized in the draft ROD document. These included:

1. Involvement of all homeowners in the four affected subdivisions in the 15-month radon study.

   a. Sixty-six of the 67 homeowners did participate.

   b. Twenty-eight outdoor sampling locations within and adjacent to

the four subdivisions were also monitored.

2. The influence of home construction on indoor radon concentrations.

   a. Data collected from the study indicated that the concentrations were closely related to the type and quality of housing construction.

   b. The average concentrations in trailers were lower than those found in homes and, in general, were approximately those found outside.

   c. The highest concentrations were found in frame houses.

3. Whether concentrations found in the homes were related to normal regional background variations.

   a. No definitive correlation was found between the distance of the individual homes from the site and the annual average indoor radon concentrations.

   b. No correlation was found between the distances to outdoor sampling locations from the site and annual average outdoor concentrations.

   c. Gamma radiation measurements did not identify significant radiation contributions from building materials.

   d. No evidence of significant radon was found in the water supply or heating systems.

   e. Uranium and radium levels in surface soils collected beneath or adjacent to homes with elevated indoor radon concentrations were typical of background levels and provided no evidence that tailings had been transported to the location of these residences.

CONCLUSIONS

EPA has concluded based on the Remedial Investigation that the uranium mill and tailing embankments at the HMC site, though potential sources, of radon near the site, are not contributing significantly to off-site subdivision radon concentrations. For the eight residences where radon concentrations were above the 4 pCi/l action level guideline established by EPA, specific guidance was provided for achieving reductions.

EPA does not feel that they have the authority to further address indoor radon problems that have not been demonstrated to be site related. They are therefore proposing no further action other than reviewing outdoor radon monitoring and particulate data collected at the HMC facility boundary pursuant to their NRC-license requirements.

ATSDR after reviewing EPA proposed actions and the reasons for the actions, concurs with the decision proposed.

Carl R. Hickam

APPENDIX C

ADMINISTRATIVE RECORD INDEX

Not included

# Appendix D

## U.S. NUCLEAR REGULATORY COMMISSION CORRESPONDENCE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

SEP 8 1989

URFO:GRK
Docket No. 40-8903

U.S. Environmental Protection Agency
ATTN: William Rowe
1445 Ross Avenue, Suite 6H-EE
Dallas, Texas 75202-2733

Dallas, Texas

Dear Mr. Rowe:

Our office is in receipt of your draft decision document for the Radon Operable Unit of the Homestake Mining Company (HMC). The Nuclear Regulatory Commission has regulatory oversight for the HMC site, which involves enforcement of applicable regulations and license conditions ensuring protection of human health and the environment. We are currently requiring the control of blowing tailings through the utilization of interim soil covers. The inactive tailings have been completely covered and thereby isolated from the environment. Additionally, due to the exceedance of ground-water protection standards, a ground-water corrective action program is being required of HMC. These two actions are consistent with your Record of Decision and the 1983 Consent Agreement signed by HMC. We will continue to pursue these items to ensure that regulatory requirements are satisfied.

Mr. Gary Konwinski of my staff will continue coordinating the efforts associated with the proposed Memorandum of Understanding between the NRC and the EPA. He will also be the contact for all environmental issues associated with the site. Please feel free to contact him directly concerning these activities.

Sincerely,

Ramon E. Hall
Director

41

Appendix E

STATE OF NEW MEXICO CORRESPONDENCE

New Mexico Health and Environment Department

DENNIS BOYD
Secretary
MICHAEL J. BURKHART
Deputy Secretary
RICHARD MITZELFELT
Director

September 12, 1989

Allyn M. Davis, Director
Hazardous Waste Management Division
U.S. Environmenta' Protection Agency
1445 Ross Ave.
Dallas, Texas 75202-2733

RE: Proposed Record of Decision for Homestake Mining Company, Radon Operable Unit

Dear Mr. Davis:

The Environmental Improvement Division (EID) has reviewed the draft Record of Decision (ROD) for the Radon Operable Unit of the Homestake Mining Company (HMC) Superfund site.

The EID agrees that the results of the remedial investigation indicate that the uranium mill and tailings embankments at the HMC site are not contributing significantly to radon concentrations in the subdivisions near the site. Therefore, the EID concurs with the selected remedy of no further action for the Radon Operable Unit as proposed by EPA.

It is understood that this action is only one part of a more comprehensive response action for the HMC site which includes three operable units: radon, groundwater, and source control. As you are aware, EID currently requires HMC to have an approved ground water protection and restoration program as authorized by the facility's Ground Water Discharge Plan (DP 200). Remedial activities addressing source control, onsite surface reclamation, and contaminated ground water are regulated by the U.S. Nuclear Regulatory Commission (NRC), pursuant to the facility's NRC license. The EID in conjunction with the NRC will continue to require HMC to implement a ground water remediation program after closure of the mill.

The uranium mill and tailings embankments are potential sources of radon in the area. As we discussed at a meeting with your staff on August 29, 1989, a provision will be included in the ROD for continued review of outdoor radon monitoring and particulate data by EPA, and the monitoring of radon in the subdivisions if warranted by future data.

– ENVIRONMENTAL IMPROVEMENT DIVISION –
Harold Runnels Building
1190 St. Francis Dr.
Santa Fe, New Mexico 87503

The EID is in agreement with the evaluation of applicable or relevant and appropriate requirements (ARARs) in Appendix A of the ROD.

Thank you for the opportunity to review the Record of Decision on HMC and for keeping us involved.

Sincerely,

Richard Mitzelfelt
Director

RM:DMD:dmd

cc: Steve Cary, NMEID
William Rowe, USEPA
Gary Konwinski, NRC

# Appendix F

# RESPONSIVENESS SUMMARY

Homestake Mining Company Site
Community Relations Responsiveness Summary

The Community Relations Responsiveness Summary has been prepared to provide written responses to comments submitted regarding the proposed plan at the Homestake Mining Company hazardous waste site. The summary is divided into two sections:

Section I: Background of Community Involvement and Concerns. This section provides a brief history of community interest and concerns raised during the remedial planning activities at the Homestake site.

Section II: Summary of Major Comments Received. The comments (both oral and written) are summarized and EPA's responses are provided.

## I. Background of Community Involvement

Individual interest or attention to the site has been very low-key. Individual residents are concerned about their health as well as the economy of the area. Frequent reports by a potentially responsible parties to residents kept them up to date.

EPA issued fact sheets and press releases to update area citizens of site activities. An information meeting was held in September 1987, prior to the start of the in-home detection study. No additional concerns were raised by these activities.

## II. Summary of Major Comments Received

The Proposed Plan fact sheet announcing the public comment period and opportunity for a public meeting were distributed on July 20, 1989. The comment period began on July 31 and was extended to September 1, 1989. At the request on four local homeowners a public meeting was held on August 28, 1989, at the Cibola Hall. The purpose of this meeting was to explain the results of the Remedial Investigation and the Feasibility Study. Fourteen people attended the meeting, and five asked questions. One additional letter was received signed by four residents.

The comments/questions received during the public comment period concerned interagency requirements at the site, and specific findings in the radon RI/FS. Comments received are summarized below, along with EPA's responses:

### Question 1.

Homestake installed the monitors, but how was EPA involved, and who was responsible for assuring data quality and correct field procedures?

Response: Under the Administrative Order (AO) signed by Homestake, the remedial investigation and feasibility studies (RI/FS) would be performed by Homestake as a potential responsible party under an EPA approved workplan, mainly developed by the State of New Mexico.

As part of this workplan, a quality assurance/quality control plan (QA/QC) was developed and approved by EPA. The plan included controlled calibration of detectors, duplicate detectors and analysis of unexposed detectors to assess accuracy and precision. All detectors were purchased from and analyzed by Terradex for long-term indoor and outdoor radon monitoring. Although the detectors were in Homestake's possession, EPA through its oversight contractor, Jacobs Engineering Group, audited all work performed by Homestake staff to insure the integrity of the results and compliance with QA/QC goals and requirements.

Under Superfund, the potential responsible party is encouraged to conduct the RI/FS work with EPA oversight in accordance with an approved work plan, which includes a QA/QC plan, as well as a worker health and safety plan.

Question 2.

Were controls applied?

Response: In all cases, controls were applied to determine the accuracy of the measurements. Each quarter, seven indoor and three outdoor detectors, 10% of each type of detector, were exposed to known radon concentrations and analyzed to establish calibration factors to adjust the field measurements. Placement and retrieval of five quarters of radon monitoring was audited by EPA's oversight contractor.

Question 3.

How is the outdoor air tested for radon?

Response: Air containing radon diffuses through a filter into a detector chamber containing a special plastic detector. Alpha particles from the decay of radon or daughter products produced within the detector volume strike the plastic detector and produce a track in the plastic. The integral number of alpha-tracks generated over a given exposure period are chemically enhanced, counted and calibrated relative to the response of the detector system to known radon concentrations. Since an integral number of alpha-tracks accumulated for a given exposure period are counted, usually three-months, the system measures the average radon concentration for the period.

Question 4.

Would the outdoor results have been different if monitors were placed close to the ground, or at a higher elevation?

Response: Probably to some extent, but the objective was to measure radon at breathing height.

Question 5.

What was EPA trying to measure with outdoor monitors?

Response: The purpose of the outdoor monitors was to detect radon levels in the subdivisions, and to determine whether there was a significant contribution of radon to the subdivisions from the Homestake facility.

Question 6.

How was it concluded that the main source of indoor radon was from the homes?

Response: It was noted that the outdoor radon concentrations were typically less than the indoor radon levels and there did not appear to be an obvious relation between indoor and outdoor radon concentrations and the mill. Local radon sources under the buildings that exceeded 4 pCi/l, combined with the quality of home construction provided a reasonable interpretation of the elevated radon concentrations observed in eight homes. Any small outdoor increment produced by the mill did not significantly effect the indoor radon levels.

Question 7.

Was there sampling made north and east of the mill and how do the measurements correlate with this study?

Response: As a license requirement windblown tailings in these areas were scrapped and placed back on the tailings pile. Perhaps a square-mile of surface was involved. These actions are under NRC supervision and authority.

There are 19 outdoor radon monitors distributed throughout these areas, at least four on the southwest Homestake boundary, which are required by the NRC operating license. The average historical results from the four monitors were in the range 1.8-2.7 pCi/l, with two of the monitors averaging slightly higher than the annual outdoor average of 1.9 pCi/l in the subdivisions. The radon averages north of the Homestake facility (15 monitors) ranged from about 0.8 to 4.7 pCi/l, with the highest concentrations near uranium mine shafts. These data were compared only qualitatively with the study results.

Question 8.

Are the results of the NRC monitoring variable or consistent?

Response: Average outdoor radon concentrations range from about 0.8 to 4.7 pCi/l according to data collected under NRC supervision and authority. The highest radon levels are associated with uranium mine areas between four and five kilometers north of the Homestake facility. Monitors located north of the facility, and within a two kilometer radius, range between 1.4 and 2.9 pCi/l.

Question 9.

Why can't radon get into the water pipes?

Response: Radon from radium in the soil under a dwelling can move into the house by passing through the space around pipes where the pipes pass through the dwelling floor. However, radon cannot diffuse through the pipes and enter the water, since the diffusion of radon through plastic or metal pipe is very low, and the radon would radioactively decay before it reached the water. In order that the water supply contribute to the indoor radon concentration due to domestic water usage, the radon levels in water must be relatively high. For example, 10,000 pCi of radon per liter of water is estimated to produce an increase in the indoor radon concentration of about 1 pCi/l. The subdivisions are on the Milan water supply.

Question 10.

Please re-iterate the distribution of dwellings having annual indoor radon concentrations exceeding 4 pCi/l and there respective relation to outdoor radon levels.

Response: Six homes are in Murray Acres, two in Broadview Acres. As noted in the viewgraph, the houses with elevated indoor radon concentration are not distributed in a discernable pattern relative to the mill location. High indoor concentrations were found only in frame houses and not in a single trailer. Also the outdoor radon concentrations observed near each dwelling were lower.

Question 11.

Explain why windblown tailings are not a source of radon in the subdivision?

Response: For the houses exceeding 4 pCi/l annual average, gamma exposure measurements were made in the near vicinity of the dwellings and in each room of the houses. In addition, a limited soil sampling program was undertaken in crawl spaces or adjacent to slabs on grade. The results from this limited assessment of potentially windblown material did not indicate that windblown tailings were significant in the soil in the vicinity of these houses. Soil sample analysis also did not indicate the presence of elevated radium or uranium.

Question 12.

Discuss the groundwater discharge plan.

Response: The groundwater discharge plan is a state responsibility and this plan has been recently renewed. Present results of water sampling in the subdivision indicate that the groundwater quality, particularly selenium, has largely returned to essentially background conditions. Information is available at the state office in Santa Fe.

Question 13.

What is the situation of windblown tailings in the subdivisions, and what has NRC required of Homestake on this topic?

Response: Analysis of windblown tailings was limited to the area in the vicinity of those houses that exceeded the 4 pCi/l annual indoor radon guideline. The NRC has identified areas to the north and east of the mill that have been impacted by windblown material and has required and overseen Homestake's cleanup efforts as part of Homestake's license requirement. NRC also requires outdoor radon monitoring at 19 locations surrounding the Homestake site, four of which are situated between the subdivisions and the Homestake mill and tailings embankments.

Question 14.

Can EPA say that there are not substantial amounts of windblown tailings in the subdivision?

Response: See response to question 13.

Question 15.

To what extent have tailings been stabilized?

Response: there are two tailings piles on the Homestake site, one active, the other inactive. The inactive pile has been stabilized to date with an interim soil cover, approximately 6 inches in thickness. Measures taken to date to reduce erosion of the active tailings pile include use of erosion control blankets, used tires, wetting with water, and with chemical agents which form a crust on the tailings surface.

Question 16.

What would you expect indoor-outdoor radon concentrations to look like over the next couple of years in the subdivisions?

Response: Provided that meterological conditions do not change abruptly in the Grants area, and assuming that homeowner living habits remain pretty much the same as over the previous two years, EPA would not expect radon levels in the subdivisions area to be substantially different in the future.

NRC license requirements, which include continued outdoor radon monitoring and the delineation of windblown tailings through radiological surveys, are intended to assure compliance with human health standards for radioactivity at uranium mill facilities.

Question 17.

What are EPA's future plans related to Homestake?

Response: Licensing conditions will continue to be implemented and overseen by the NRC. Continual surveying and cleanup of windblown tailings will be required. Eventually, complete reclamation of the site and impacted vicinity properties will occur as required by NRC regulations. In place boundary radon monitors will continue to ensure that regulatory compliance is met. The EPA and the NRC will have an agreement to delineate respective regulatory responsibilities for the Homestake site.

The following are responses to one written comment received by EPA during the public comment period.

Concern 1.

HMC's erosion protection efforts to mitigate windblown tailings from its main tailings embankment are judged to be insufficient since wind blown material is still observed in the direction of the subdivisions when the wind direction is from the north/northeast.

Response: Windblown tailings are a concern in so far as the radon produced potentially may impact public health in the unrestricted, off-site environment. It is EPA's understanding that improvements to reduce the extent of wind erosion have been made through the use of crust forming agents, net blankets, tires and fencing. To compliment these activities, cleanup requirements for the off-site environment have also been imposed as a licensing condition by the NRC. Recent implementation of these requirements took place in 1988 resulting in the cleanup of the main impacted areas to the north of the county road adjacent to the main property, as well as east of Hwy. 53 (RI Figure 15). Such efforts are expected to periodically continue, and a complete survey and cleanup of all potentially impacted vicinity properties will be a NRC imposed condition of final remedial action and mill closure. Public exposure to radioactive, airborne particulates in the off-site unrestricted areas to the south and southwest of the site is continually assessed on the site boundaries as a NRC licensing requirement. Compliance with 10 CFR 40 will be overseen by the NRC and reviewed by the EPA.

However, from the prespective of this radon study the issue of concern is whether the windblown tailings significantly impact indoor radon concentrations in the subdivisions. This issue will be addressed more fully in response to concern 5.

Concern 2.

EPA has stated that the in-place aquifer restoration program has largely flushed mill generated groundwater contaminants from the alluvium and Upper Chinle aquifers. Would EPA provide evidence to support this observation and state its official opinion as to the how long this restoration program will be continued?

Response: The New Mexico Environmental Improvement Division (NMEID) monitors wells in the subdivisions to assess the performance of the pump back system on a semi-annual basis. The water sampling data is a matter of public record and may be obtained from the NMEID. A review of this data can be made to individually judge the success of this system to restore water quality in the alluvial and Upper Chinle aquifers.

The maintenance of a groundwater control program and associated downgradient well monitoring probably will be required throughout the operation of the mill to ensure that groundwater contamination is restricted to the on-site environment. Upon mill closure, site reclamation is expected to occur in accordance with NRC regulations (10 CFR 40, Appendix A) and licensing requirements. NRC requirements will dictate design conderations to comply with appropriately accepted long-term groundwater quality relative to the stabilized tailings piles. Long-term groundwater corrective action will include points of compliance, and ground water protection standards to be met (such as background water quality, maximum or health based alternate concentration limits). The NMEID will work closely with NRC on the direction of the corrective action program.

Concern 3.

The historical section of the RI has mistakenly portrayed the community's irrigation well as 1000 feet deep. The actual Murray Acres irregation well of 585-feet pumping water from the San Andres formation. Furthermore, most of the homeowners use shallow wells, 90-300 feet deep, to irrigate yards and gardens using the alluvial and Upper Chinle formations.

Response: The Final RI Report acknowledges that the San Mateo alluvium, Upper Chinle and San Andres Formation aquifers have been used for irrigation water in the past. The FS states that significant irrigation is derived from the San Andres formation (approximately 1000 feet deep). This statement was not intended to refer specifically to the 585-foot deep irrigation well in Murray Acres (well log #806 on file with NMEID). There are a number of San Andres wells in the subdivisions area which are used for irrigation. These wells have a range of depths, and have an average depth of approximately 1000 feet.

Concern 4.

In an off-the-record statement by Mr. Kennedy of HMC, it was devulged that there was no evidence of windblown tailings outside of HMC's property. This statement directly contradicts a 1979 NRC study, which implied that Ra-226 and Pb-210 surface soil contamination could be distinguished above background at distances up to 5 miles from HMC's mill. In addition, this article indicated that windblown contamination residing in the uppermost four centimeters (cm) of topsoil is contributing about 1.6 Ci per day above the natural background.

Response: EPA was not a party to the refered conversation and, therefore, will restrict its response to a substantive interpretation of the article cited.

The soil sampling plan implemented was limited to radial transects (22.5 degree) with soil samples collected at 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 mile increments. Approximately 20 soil samples were in the subdivisions area. The radium-226 soil concentration isopleths essentially reflect the wind rose distribution with the major windblown contamination plume in the north/northeastern directions. Soil concentrations elevated 2.3 pCi/g above background are observed as far as 5 miles to the north/northeast of the HMC site. However, in the south/southwest direction, this 2.3 pCi/g contour is only about 1.2 miles from the main embankment center. The next highest concentration contour in this area, 4.5 pCi/g, lies about 0.75 miles from the site followed by a 9 pCi/l contour at 0.5 miles. The 9 pCi/l isopleth appears to be almost entirely within the HMC property boundary.

From the limited analysis performed on this study, it appears that any windblown tailings in the subdivisions would be on the order of the surface soil cleanup standard adopted by the EPA for remediation of inactive uranium mill sites, 40 CFR 192, and contained in 10 CFR 40, Appendix A for active mill sites: 5 pCi/g above background averaged over the top 15 cm soil depth and a 100 m 2 area. The radiological impact of this material in the subdivisions would be considered minimal.

The areas to the north, northeast and east of the site, that the study indicates may be contaminated above the 5 pCi/l cleanup criteria, roughly correspond to those on-site and off-site areas recently cleaned by HMC as an NRC licensing requirement (RI Figure 15). Accordingly, the radon flux capacity of this distributed material has been returned to the north side of the main embankment. Since the contamination is mixed with uncontaminated soil in the removal operations, the effective emission rate is probably reduced in its present disposition.

From the above discussion it is reasonable to assume that the dominant potential outdoor radon source in the vicinity of the subdivisions would be the main tailings embankment, and not off-site windblown tailings.

Concern 5.

The evidence supporting the notion that the main embankment is not significantly impacting the radon levels in the subdivision is insubstantial and the conclusions may or may not be valid.

Response: The main objectives of the study's work plan was to determine whether indoor radon concentrations in subdivision residences exceeded the 4 pCi/l annual guideline, to identify sources and contributing mechanisms for residences that exceeded this recommended limit, and determine appropriate remedies. The study was limited to only the residences in the subdivisions and not a general study of indoor residential radon, nor was an extensive determination of background included as part of the work plan. Therefore, the inclusion of homes outside the study area was not considered appropriate or relevant to the analysis of the probable causes of indoor radon concentrations in a particular subdivision residence that exceeded 4 pCi/l.

The fact that the length of time that a residence has been situated on a site was not considered in the study does not appear to be a significant flaw. Presummably this issue was raised to imply that the long-term accumulation of windblown tailings within or around the dwelling could significantly affect indoor levels. As noted in the discussion of the 1979 NRC report, windblown tailings in the area of the subdivisions appears to be minimal. Although the gamma-exposure measurements and soil sample analysis performed as part of the RI study were limited and considered only dwellings with indoor concentrations exceeding the adopted guidelines they did not indicate that a more comprehensive study of windblown tailings was justified. Also, it should be noted that a six-inch deep soil sampling protocol is considered appropriate to assess windblown contamination.

The issue of interest is not whether the mill incrementally increases the outdoor radon concentrations in its vicinity, but whether the increment signifcantly influences indoor concentrations. The general structure for atmospheric dispersion of radon from the main tailings embankment would be similar to that for particulates. If the measured outdoor concentrations consistently exceeded indoor levels one would reasonably assume that the outdoor air could potentially influence the indoor environment. However, the RI results indicate that indoor

concentrations, for the most part, are higher than the nearby outdoor levels. Furthermore, there is a correlation of indoor radon concentrations with construction quality and dependance of outdoor radon concentrations will mill location is not readily apparant. Accordingly, it is not unreasonable to conclude that any incremental radon contribution from the mill is not significantly impacting indoor radon concentrations and that construction characteristics of the individual dwellings relative to local soil radioactivity tend to dominate.